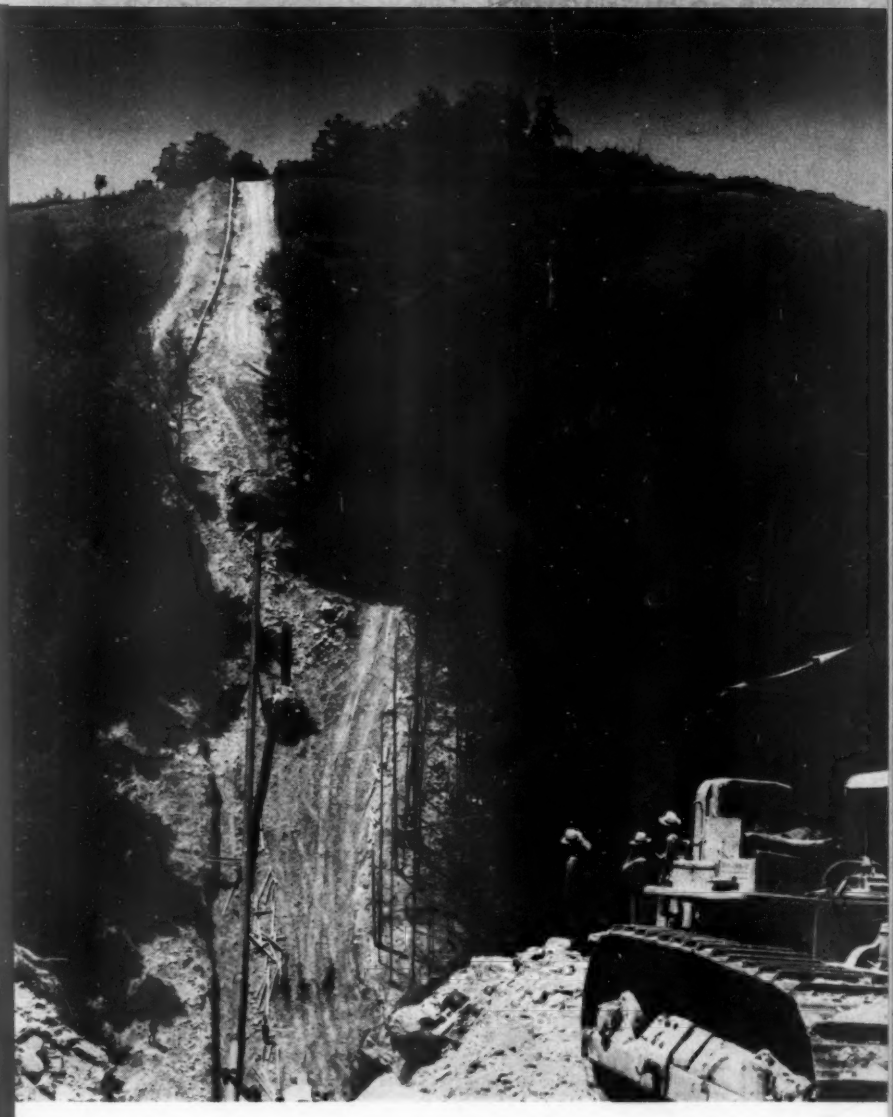
The OIL AND GAS JOURNAL



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Trends

Crude-Oil Production
By States—Page 304

CRUDE-OIL STOCKS 220,623,000 bbl. as of September 9—down 2,859,000 bbl. One year ago 234,389,000 bbl.

GASOLINE STOCKS 79,576,000 bbl. as of September 9—down 345,000 bbl. One year ago 71,018,000 bbl.

RESIDUAL FUEL-OIL STOCKS 60,735,000 bbl. as of September 9—up 859,000 bbl. One year ago 66,743,000 bbl.

GAS OIL AND DISTILLATE STOCKS 43,053,000 bbl. as of September 9—up 1,089,000 bbl. One year ago 38,051,000 bbl.

CRUDE-OIL PRODUCTION 4,742,100 bbl. as of September 16—up 45,300 bbl. One year ago 4,368,710 bbl.

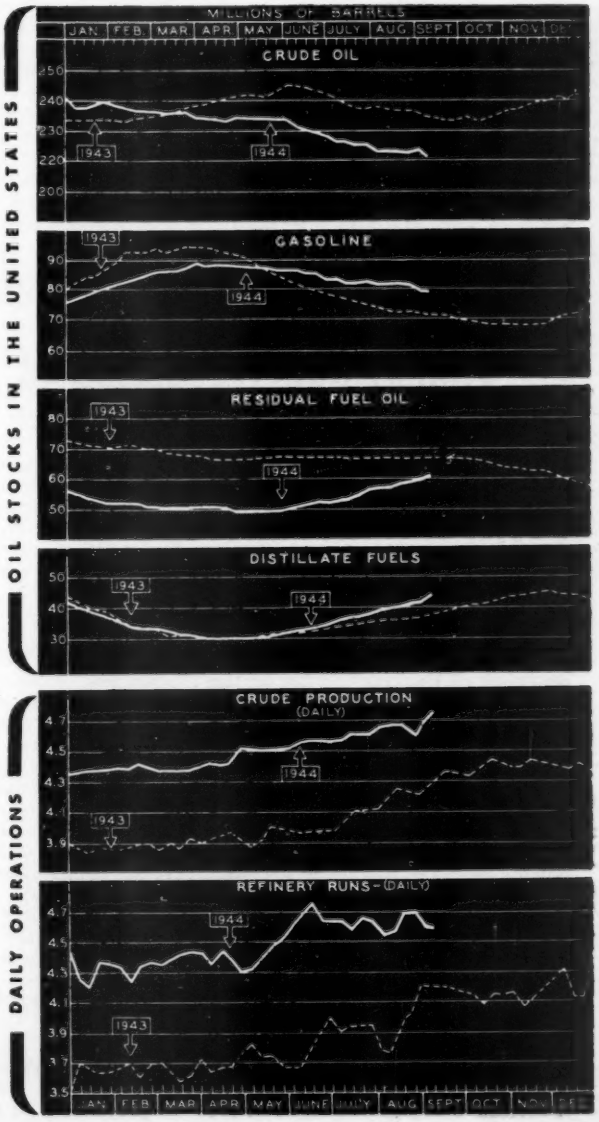
REFINERY RUNS 4,584.000 bbl. daily week ended September 9—down 8,000 bbl. Year ago 4,225,000 bbl.

AT the A.P.I. annual meeting in San Francisco in November 1941 it was predicted that within 1 to 3 years producers in this country would be called upon for 5,000,000 bbl. of oil daily. These speakers based their forecasts on the rapid increase in the needs of 1941, which reflected the nation's defense activity; oil shipments to the Allies, and general prosperity, with the accompanying large growth in domestic demand. There were many informal discussions at San Francisco as to the ability of the domestic industry to produce at the 5,000,000-bbl. level, with general agreement that it could not be accomplished except through greatly enlarged drilling activity.

LAST WEEK, with drilling still under the 1941 mark and following a period of 1942 and 1943 in which drilling activity was about 50 per cent of the prewar level, oil producers in the United States brought to the surface an average of 4,742,100 bbl. daily, a new record. With an estimated production of 289,100 bbl. daily of distillate and associated products this means that national output last week exceeded the 5,000,000 level by 31,200 bbl. daily. In the light of postwar needs and the San Francisco discussions as to what the several oil areas could or could not do in a 5,000,000-bbl. production effort the following table, summarizing last week's output and that of the week in December 1941 which included December 7, is of interest:

State—	Last week	Dec. 1941	+Increase —Decrease
Arkansas	81,150	73,590	+7,560
California	879,400	665,250	+214,150
Eastern fields	71,800	110,850	—39,050
Illinois basin	241,900	384,195	—142,295
Kansas	280.300	255,950	+24,350
Louisiana	363.000	357,695	+5,305
Michigan	50 100	56.890	—6,790
Mississippi	43.600	75,535	—31,935
Nebraska	900	5,200	—4,300
New Mexico	105,900	118,580	—12,680
Oklahoma	342.200	415,975	—73,775
Rocky Mts.	125,750	112,940	+12,810
Texas	2,156,100	1,478,900	+677,200
U. S.	4.742,100	4,111,550	+630,550

This comparison shows that seven states and areas have had increases in production over the past 3 years while the same number report decreases. The gain in Texas exceeds the national increase and most of the expansion in that state has been in West Texas and the Gulf Coast area.



Subsidy May Be Extended to High-Cost Fields Shortly

WASHINGTON. — Standards are nearly developed for the inclusion of high-cost operation pools in the stripper-well subsidy program, an Office of Price Administration spokesman said last week. A meeting of representative producers was held in Washington September 21 to polish off details of a plan which will put this portion of the Vinson directive on oil-price subsidy into action. The new program is expected to bring many new pools under the program, affecting those which produce more than 9 bbl. a day, the current limitation, but classed as high-cost operations.

OPA will also issue an order revising the current list within a short time, the new order to be effective probably October 1. Changes to be made include the following:

Texas: Bateman Ranch, King County, will be removed from the subsidy program. It was included originally because this field, discovered in 1943, had not been put into production owing to lack of storage and transportation facilities. It is now a flush field. Powell pool, Navarro County, will be added at 20 cents per barrel.

Kansas: All pools in Crawford County added at 35 cents; Kruse, Rooks County, 25; Hollow-Nikkel, Harvey, 20, and the Brown pool, Cowley County, 25 cents.

Michigan: Geneva, Van Buren,, added at 35 cents.

Oklahoma: Platter, Osage, 35 cents; Sams (Pennsylvania), Noble, 35; Sams (Oswego), Noble, 35; Reed, Garfield, 25, all added.

Indiana: Rockport pool, Spencer, subsidy changed to 35 cents.

Illinois: Dundas, Richland and Jasper counties, changed to 25 cents.

Wyoming: North LaBarge unit area, Sublette County, added at 35 cents.

West Virginia: All other pools not previously priced, added at 35 cents.

Pending Oil Treaty Is Blasted as Violent Supererogation of Power

WASHINGTON. — The Anglo-American oil treaty now pending in the Senate "involves the most violent supererogation of federal power at the expense of our existing constitutional system that has ever been attempted through the legal back door of the Constitution in our diplomatic history, in a kindly, innocent and benevolent guise," declared George A. Hill, Jr., president of Houston Oil Co., at the 1-day session of Petroleum Industry War Council here September 13.

Hill was one of 10 oil executives who served as technical consultants to the State Department when the agreement was drafted. As an individual member of the council Hill read a memorandum outlining his objections to the treaty. He declared that if ratified it would give the federal Government more power over the oil industry than the Constitution gives it, and he suggested that the agreement has many aspects of a government-dominated cartel.

Charles B. Rayner, special assistant to the Secretary of State, and Ralph K. Davies, deputy petroleum administrator, both members of the American delegation which drafted the agreement, were present at the council meeting and they took exception to Hill's interpretations and conclusions. The council took no action on the treaty, but referred it to the national oil-policy committee, which is expected to make a report at the next meeting, scheduled for October 25.

Potential Authority

Hill contended that creation of a federal power in the Congress of the United States or an International Oil Commission over and in excess of the powers delegated to Congress under the Constitution "can be lawfully and successfully achieved by merely predicating this new body of congressional powers on the treaty itself as the supreme law of the land."

"The 'constitutional procedures' referred to in the proposed treaty," Hill asserted, "are completely modified as they now exist under our federal Constitution by the simple ratification of this federal agreement by the U. S. Senate. It binds the U. S. Government to exercise powers which are beyond present congressional authority under the Constitution, except for utilization of the petroleum agreement itself as the basis for new congressional authority, and which could only be achieved otherwise by an amendment to the Constitution.

"The subtle and ingenious device of an international treaty, ratified by a two-thirds vote of the Senate, can erect a species of lawful federal control of the oil business, in various aspects and phases not now existent in the Congress. This unassailable legal device can be similarly employed in all kinds of international treaties receiving Senate approval and ratification and affecting any matters that might become the subject matter of international negotiation."

Points in Argument

The proposed treaty, Hill said, assumes federal power:

"1. To regulate and allocate production upon the consideration of 'available reserves' within various oil-producing nations of the world, conjointly with the British and future signatories.

"2. To make allocations and production quotas upon the basis of a determination of 'sound engineering practices' that may or may not be wholly or partially observed, from time to time, in various producing areas of the world.

"3. To make allocations and production quotas in various producing areas of the world in relation to what may be considered 'relevant economic factors.'

"4. To make allocations and production quotas in various producing areas of the world on what may be assumed to be to the interest of 'producing countries.'

"5. To likewise make allocations and production quotas in various producing areas of the world in relation to 'the interests of consuming countries.'

"6. To make allocations and production quotas with a view to the 'full satisfaction of expanding demand,' all of which spheres of asserted congressional power are new adventures in asserted federal authority that must derive from a duly ratified treaty enjoying the dignity of the supreme law of the land."

The proposed treaty, Hill said, as a prerogative lawfully accruing to the Congress and the Government of the United States from the legal consequences of its ratification, assumes federal power for these further reasons:

1. To fix what is considered to be a fair price for petroleum supplies to the nationals of all peaceable countries and on a nondiscriminatory basis which embraces the assumed power of price fixing.

2. To determine from time to time what country is "peaceable" and what countries are "not peaceable" and what are the shifting criteria in

making such determinations in conjunction with other parties signatory to the treaty a far more delicate and dangerous adventure in diplomacy than our variable policy with respect to the recognition or nonrecognition of the Latin-American governments in the Western Hemisphere.

3. To assume, as a function of government, the determination of what is, or is not, in all aspects of private trade and commerce in oil supplies among the nationals of all peaceable countries in relation to the matter of discrimination, over and beyond fairness and equity in the matter of pricing.

4. To undertake exercise of federal power so to control the development of "petroleum resources and benefits received therefrom by the producing countries" as to "encourage the sound economic advancement of those countries," even though, possibly, the current American concept of sound economy might be regarded in one or more of the producing countries involved as a deterrent instead of an advancement.

Entering Wedge for Cartels

"The proposed treaty is the design for the progressive germination of cartels under government blessing," the Houston oil man declared. "A reconsideration of this treaty may have provoked the letter of the President, dated September 8, to Secretary of State Hull calling for a curb on cartels and in which letter it was stated that a cartel is defined by economists as a system of controlling prices, production and of allocating markets by agreements. The implication with respect to the cartelization of the oil industry cannot be escaped."

Moreover, Hill said, the device of the treaty provision making petroleum supplies available in accordance with the principles of the Atlantic Charter is of vast significance in that there is created an affirmation of the principles of the Atlantic Charter and the indirect attachment of the consequences of treaty ratification to such principles, concerning which the United States has made no reservations. And this, he added, notwithstanding that the Prime Minister of Great Britain has made for his government the most significant of reservations in favor of that form of economic discrimination known as "imperial preference" for and within the British Empire, and with "the expressed" purpose of retaining to the House of Parliament and to the Dominions the fullest possible rights and liberties over the question of imperial preferences.

Hill said that under the treaty, legislation would undoubtedly be necessary at times to fix prices of oil or to compel production or sale of oil, whether produced in this country or in American-owned concessions abroad; legislation requiring companies with foreign concessions to pay greater royalties to foreign governments than required by terms of the concessions; the setting up of some sort of machinery to determine whether a nation is "peaceable" in order to be entitled to purchase oil.

The treaty, Hill continued, would require repeal of the General Leasing Act, which denies benefits of the act to aliens of countries whose legislation denies similar privileges to nationals of this country. Thus, he explained, the United States would be under obligation to grant to any alien applicant the same lease and prospecting permit as would be granted to a citizen of the United States.

"It is evident," Hill summarized, "that much of the foregoing legislation could find no support in powers delegated to Congress by the Constitution. This does not mean, however, that the Government is unable to carry out the obligations envisaged in the proposed oil compact, but merely indicates that the compact must be cast in the form of a treaty in order that the legislation may have a basis recognized by the courts as valid."

Rise in Demand Forecast if European War Continues

WASHINGTON.—Total petroleum demand for the first quarter of 1945 will rise to 5,565,000 bbl. daily, if the European war continues. This conclusion was reached by the Petroleum Industry War Council's committee on petroleum economics which admitted in the report submitted here last week that cessation of hostilities in Europe would force a downward revision in estimated requirements.

Figures on military requirements after close of the European war are not available, the committee reported, but substantial reduction in military requirements for gasoline is expected when Germany is defeated, releasing more motor fuel for civilian consumption.

In anticipating petroleum supply and demand and inventory situation from September 1, 1944, through March 31, 1945, Chairman Robert E. Wilson of the committee on economics admonished that if the war in Europe should end abruptly there will be major shifts in demand which will result in circumstances entirely different from the current forecasts advanced by the committee.

As of today, however, the PIWC committee reported:

"It is not unlikely that the end of the European phase of the war will occur during the term of this report. In that event small balances shown as yet to be supplied will have been only paper deficiencies, and the situation with respect to inventories generally will have improved comparably."

The committee estimated the petroleum demand in the United States during the fourth quarter of this year would average 5,437,000 bbl. daily, while in the first quarter of 1945 the demand that had to be considered totaled 5,565,000 bbl. per day.

Demand Rise in Two Areas

"These unprecedentedly high figures represent levels greater than demands in the comparable periods of the winter of 1943-1944, when the then producing and refining capacities of the country were considered to be close to their limits," the committee reported.

"The principal increases are in the Gulf Coast and West Coast states, reflecting mainly military requirements. The military demands which were included were based upon a world-wide consideration of all of the United Nations, petroleum needs and represent the net amount remaining after the deduction of the

TOTAL PETROLEUM DEMAND INCLUDING ESSENTIAL DOMESTIC AND RATION REQUIREMENTS AND UNITED NATIONS' NEEDS

(Thousands of barrels daily, by quarters)

	1943	1944					1945
	Fourth	First	Second	Third	Fourth	Year	First
Gasoline	1,784	1,802	2,046	2,123	2,106	2,019	2,057
Kerosene	219	256	178	182	250	217	299
Distillate	645	781	628	621	732	690	837
Residual	1,369	1,384	1,303	1,280	1,446	1,353	1,526
Lubricants	114	107	115	121	134	119	129
Asphalt	100	66	107	135	107	104	73
Other, crude oil and loss	517	504	551	621	662	585	644
Total demand	4,748	4,900	4,928	5,083	5,437	5,087	5,565

maximum supplies foreseeable at this time from all United Nations' sources outside of the United States."

The committee predicted that United States petroleum production during 1944 will average the almost inconceivable volume of 4,587,000 bbl. daily of crude oil and 288,000 bbl. daily of natural gasoline and allied products, to total new domestic supply of 4,875,000 bbl. a day.

The committee said total production is expected to average 5,028,000 bbl. daily in the first quarter of 1945.

California Situation

Because of the developing importance of a thorough understanding of the California supply and demand and inventory situation, the committee included a statistical analysis of the situation in District 5. Analyses on District 5 assumed that both the European and Pacific phases of the war will continue throughout the first quarter of 1945.

"Crude production estimates," the working subcommittee reported, "are more optimistic than presented heretofore, varying from 865,000 bbl. per day during September to 892,000 bbl. per day during the first quarter of 1945. These figures include 8,000 bbl. per day of new Elk Hills production in September and 28,000 bbl. per day during the first quarter of 1945.

"Receipts of crude and products from other districts, all by tank car, vary from 122,000 bbl. per day in September to 131,000 bbl. daily in the first quarter of 1945.

"Total available supply, representing the district supply of crude oil, natural gasoline, etc., and receipts from other districts, varies from 1,039,000 bbl. per day in September to 1,077,000 bbl. per day in the first quarter of 1945. Since demand, including shipments to other districts, for crude and products, varies from 1,046,000 bbl. per day in September to 1,187,000 bbl. per day during the first quarter of 1945, 7,000 bbl. per day of demand must come from inventories during September and 110,000 bbl. per day during the first quarter of 1945. With the possible exception of distillates, including cutter stock for special Navy fuel oil, it is believed that the district can handle these demands. Inventories decrease from 87,300,000 bbl. September 1, 1944, to 69,600,000 bbl. March 31, 1945, a reduction of 17,700,000 bbl. during the 7-month period.

"As of March 31, 1945, the anticipated total inventory figure of 69,600,000 bbl. is 10,100,000 bbl. above the minimum working stock level. Of this excess, 4,000,000 bbl. represents crude oil which should be run to stills as early as possible, and 4,100,000 bbl. is shown as gasoline. This gasoline is mainly naphtha distillate and 91-octane aviation-gasoline stock, the latter resulting from reduced future demand by the military in the face of sustained maximum production under present directives. Kerosene and distillate combined will be 2,500,000 bbl. below minimum operating levels March 31, indicating the critical outlook for these products. The balance of the excess is distributed among other products, of which the largest item is 1,600,000 bbl. of heavy fuel oil.

"The principal reason for the anticipated distillate shortage is the requirement for this grade of charging stock by the new catalytic cracking facilities, a part of the 100-octane aviation-gasoline expansion program. It is possible that this distillate shortage may be partially relieved by alterations in the refining program by adjusting the quality of other products."

Pressure-Maintenance Operations Spread by Economic Attraction

WASHINGTON. — Expansion of pressure-maintenance operations was cited here last week at the regular meeting of the Petroleum Industry War Council as a trend in producing operations which will receive significant stimulation after the war when materials are freely available. Operators of 23 compressor installations for pressure-maintenance projects approved and sponsored by the Natural Gas and Natural Gasoline Division of the Petroleum Administration for War expect to increase ultimate recovery by approximately 170,000,000 bbl., at an average cost of 10 cents per barrel.

The PAW division announced that it is planning issuance of an order prohibiting the use of butane in development-well drilling. The forthcoming order will be directed to those drilling operations which are so located that a few miles of pipe line would provide natural gas for fuel. It is estimated, the division report continued, that approximately 250 to 300 drilling rigs now using butane for fuel will be affected.

Preliminary reports indicate that by October 1 there will be a butane shortage of 5,000.000 to 7,000,000 gal. per month which, the division reported, the prohibition on its use as fuel in development drilling is expected to ameliorate.

"Since the organization of the Natural Gas and Natural Gasoline Division," the formal report stated, "a considerable amount of equipment has been devoted to the installation of compressors for pressure maintenance. Approximately 23 such installations either have been completed or are under construction, some as separate plants, and some as part of natural-gasoline-recovery operations. To date, almost $16,000,000 have been expended in these plants both for natural-gasoline recovery and pressure-maintenance compressors. Approximately 50,000 hp. will be devoted to returning residual gas to the producing formations. At an estimated cost of $120 per installed horsepower, there will have been expended about $6,000,000 just for compressors.

"From data submitted in the various applications involved, the additional oil ultimately to be recovered as a result of these pressure-maintenance facilities is in excess of 170,000,000 bbl. . . . Completely neglecting the cost of absorbers, stills, pumps, etc., in these plants, for recovering natural gasoline, 170,000,000 bbl. or more of oil for an investment of $16,000,000 or less than 10 cents per barrel, is cheap oil."

CAA Given Authority Over Private-Plane Fuel

WASHINGTON. — The War Production Board has assigned to the Civil Aeronautics Administration responsibility for distribution of 73 and 80-octane aviation gasoline to private airplanes, effective November 1. Previously the Office of Price Administration handled this rationing since practically all of it was to flying schools. Curtailment of primary training has released many private planes and both planes and their gasoline will now be controlled by CAA. Before November 1 CAA will issue regulations governing sale of gasoline to private fliers by gasoline suppliers.

Jones Heads District 1 General Committee

WASHINGTON.—W. Alton Jones, president of Cities Service Oil Co., has been appointed chairman of the Petroleum Administration for War's general committee for District 1, succeeding the late John A. Brown. Jones' successor as chairman of the East Coast supply and transportation committee has not yet been named by Petroleum Administrator Ickes.

THIS WEEK

PRODUCTION—Daily crude output of 4,742,100 bbl. topples all-time record of preceding week. . . . Gains in Kansas and California canceled decreases in other areas. . . . ¶First 6 months' operation of horizontal-well project in Pennsylvania shows 56 times as much oil recovered per acre as was produced in 1940 and 1941 by vertical wells on same lease. . . . ¶Norman Wells, now second largest producing field in Canada, delivering about 3,375 bbl. of crude daily to Canol refinery at Whitehorse, with pipe line operating at capacity. . . . Potential output believed twice current pipe-line runs. . . .

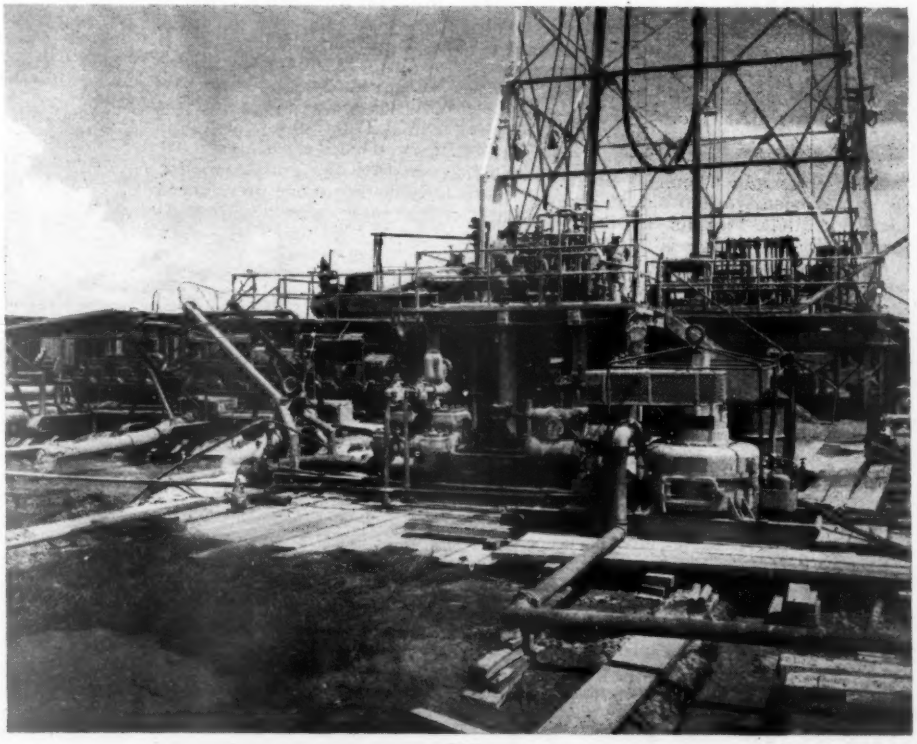
ENGINEERING—Geologists and operators in West Edmond field about convinced only nature can solve enigma of salt-water encroachment on southwest flank. . . . "Gets on your nerves when you try to figure it out." . . . ¶Rejuvenation of 22-year-old Blossom sand pool in Stephens field, Arkansas, now producing less than 3 bbl. daily, to be attempted by reinjection of natural gas. . . . ¶Bureau of Mines reports more than 4,000,000 bbl. of oil has been recovered in Kansas by injection of 41,000,000 bbl. of water since 1936. . . .

REFINING—PAW allocates 1,173,000 bbl. of gasoline daily for civilian use in fourth quarter, a drop of 77,000. . . . East Coast, Midwest, Rocky Mountain and West Coast regions gets less. . . . Southwest gets a little more. . . . ¶Stocks of heavy fuel, especially on East Coast, at high levels, threatening to hinder war-production output in eastern and midwestern plants. . . . ¶Directive issued March 1943, allocating to specifically designated refineries in Midwest crude needed to meet war requirements, is revoked. . . . Individual directives now issued by District 2 director-in-charge. . . . ¶Universal Products Co. turned over to American Chemical Society.

SYNTHETICS—Interior Department examining sites for three plants to experiment with methods of obtaining synthetic liquid fuels from oil shales, coal and other substances. . . . Ickes says 100 locations offered. . . . ¶Frank Phillips predicts chemistry of tomorrow will be based largely on petroleum hydrocarbons, available in virtually limitless quantity. . . . Demands for synthetic rubber, petroleum chemicals and other products hold great postwar promise. . . .

FOREIGN—Study of Anglo-American pact creating skepticism. . . . George A. Hill, Jr., decides it is "violent supererogation of federal power through back door of Constitution." . . . "Design for progressive germination of cartels under government blessing." . . . ¶Beauford H. Jester, chairman Texas Railroad Commission, fears it will prove "entering wedge for federal control over domestic oil production." . . .

CONSTRUCTION—Completion of 3-year program involving plants producing 67 per cent of country's aviation gasoline announced to have represented investment of $500,000,000 by the oil industry. . . . More than 50 installations now turning out vital war products. . . . ¶Contract awarded for three new fractionating towers, costing $800,000, at cycling plant in Katy field, Texas.



This rig is representative of the large assemblies used to combat hazards of deep drilling on the Gulf Coast where abnormal gas pressures and hot salt-water flows require most modern equipment. The mud system includes a centrifuge, right foreground, to assist in retaining the desired properties and two 20-in. duplex pumps and one triplex pump for regular circulation

Oil Companies Give U.O.P. to A.C.S. at New York Meeting

by Arch L. Foster

PRESENTATION of a gift of a 10 to 15 million dollar research and development organization with an income estimated at approximately 1 million dollars annually, was the highlight of the largest annual meeting of the American Chemical Society ever held, in New York, September 11 to 15. Nearly 10,000 chemists from all over America and several foreign countries were present.

The company which was given as a research organization, intact, to the A.C.S. is Universal Oil Products Co. of Chicago and New York. It was proffered to the society in the name of its oil company owners through Dr. Thomas Midgley, Jr., president of A.C.S. Dr. Midgley stated that the gift of U.O.P. has been accepted by A.C.S. directors "in principle," and that a special committee has been appointed to complete final arrangements for transfer of ownership. Application of the work of the organization and the income from it to the furtherance of scientific research in the petroleum industry is one of the stipulations of the gift, it is understood.

While the details of the ownership of the company, other than that it shall be owned 100 per cent by the American Chemical Society, have not been worked out, it is understood that "results of the research (by the Universal staff) will be published and made available to the public without charge. The donors will have no rights to such results greater than those of the public at large." This appears to mean that the research results and process developments of the company become the property of the society and the literature of science in the same manner as is any published scientific data. It is also indicated that the licenses of the company in the petroleum process field, more than 100 in number, will continue as before.

While no announcement has been made, it is probable that this is the largest gift ever made to the society which is the largest professional organization of its kind in the world with a membership of nearly 40,000.

Triptane, that most efficient of aviation fuel components, is being produced to the extent of several gallons per day, Dr. Charles F. Kettering, vice president of General Motors Corp., in charge of research and development, announced at the meeting. The quantity produced is sufficient to permit extensive testing in planes, it is understood, and the development probably will have a far-reaching effect on automotive and aviation-engine improvement in the postwar period, Kettering said. Triptane is the more common name for 2, 2, 3-trimethyl butane, long known to scientists of the fuel and automotive industries. It has been extremely expensive to produce since the synthesis is involved and costly, as high as $3,000 per gallon being quoted as typical. Dr. Kettering believes that when the war is over and raw materials are available and more of the fuel can be diverted to research and commercial purposes, the cost may be reduced to between 50 cents and $1 per gallon. The antiknock rating of triptane is variously estimated as of the order of 125-130 octane number, a value which is a misnomer since no known method exists for rating fuel detonation properties in terms of the octane scale above 100. Suffice to say the antidetonation characteristics are more pronounced by far than are those of isooctane (2, 2, 4-trimethyl-pentane), the present standard 100-octane number for the A.S.T.M., Research and other methods of testing. "Boss Ket" indicated the relative efficiency of triptane as a superfuel by saying that in suitable engines this fuel will give four times the amount of power on the driveshaft, with one-fourth less fuel consumption, than presently used fuel of 100-octane number.

It will be recalled that Universal Oil Products Co. last year announced the discovery of a method of synthesis of triptane by Drs. Haensel and Ipatieff as a contribution to the technology of the oil industry. The methods employed by either Universal or General Motors are not known; that of General Motors may be of the chemical type, while that of Universal may be some condensation reaction between hydrocarbons of lower molecular weight, both probably being catalytically actuated.

KURTZ ELECTED PETROLEUM DIVISION CHAIRMAN

In the annual election of the Petroleum Division of the American Chemical Society the following officers were elected:

Chairman: S. S. Kurtz, Jr., Sun Oil Co.

Vice chairman: C. L. Thomas, Universal Oil Products Co.

Secretary: C. R. Wagner, consultant (reelected).

Executive committee: C. L. Brown, Standard Oil Co. of La., retiring chairman, and W. E. Bradley, Union Oil Co.

Intensive Research Urged

A plea for more intensive postwar scientific research with a federal program of scholarships financed by the national government was made by Dr. James Bryant Conant, Harvard University president, upon his acceptance of the society's award of the Priestley Medal for distinguished service to science. In return for the award of these scholarships to the most promising high school students, the latter would "make themselves available in time of national emergency for any national service the Government demanded." Conant urged a "minimum" of governmental control and direction of scientific research; urged industry to avoid "raiding" the colleges for the most promising scientists and engineers; asked that colleges and universities give professors more time for research.

Catalysis Symposium

Outstanding in the long, 39-paper meeting of the Petroleum Division was the symposium on catalysis and catalysts (abstracts of which appeared in the Journal, September 16, page 95). Leading chemists and engineers in the industry are studying the catalysts employed or employable, in the light of the most recent theories and methods. Some of the leading reports were those on the fluidized "fixed bed" catalytic cracking system by Thomas and Hoekstra, Universal Oil Products Co., a relatively new system which may importantly affect the catalytic cracking field; isomerization of light paraffin hydrocarbons commercially, by Evering, Fragen and Weems, Standard Oil Co. (Indiana), for octane number improvement without appreciable cracking, a reaction possibly amounting to a type of catalytic reforming; catalysts for synthesis of liquid hydrocarbons (Fischer-Tropsch) by Storch, Bureau of Mines, and many other papers dealing with catalytic cracking and catalysts for these and other refining processes.

Gasoline Allocations Reduced

WASHINGTON.—Gasoline allocations of 1,173,000 bbl. per day for the fourth quarter of 1944, announced by Petroleum Administration for War, show a drop from the third quarter of 77,000 bbl. Of the decreases, 49,000 bbl. is in the allocation to the War Food Administration, reflecting seasonal farm-usage declines, and 26,000 bbl. in the allocation to the Office of Civilian Requirements for off-highway requirements. Claims of these two agencies were met in full.

Office of Defense Transportation, claimant agency for passenger cars, trucks, buses and other forms of transportation, received an allocation of 1,013,000 bbl. per day, a decrease of 2,000 bbl. from its third quarter allotment. The ODT allocation (see table) shows increases of 3,000 bbl. per day in District 2 (Middle West) and District 5 (Pacific Coast), 5,000 bbl. per day in District 3 (Southwest), and 13,000 bbl. per day decrease in District 1 (East Coast). The ODT claims were met completely except in District 1, where the allotment was 9,000 bbl. per day short, and District 5, where the allotment was 2,000 bbl. per day short.

Industry sources interpreted the failure to meet District 1 claims of the ODT by 9,000 bbl. per day in the face of a total decrease of 26,000 bbl. per day in supplies to that district, compared with the third quarter, as evidence that transportation facilities are still inadequate to meet all requirements of that area during the peak fuel-demand period, while military requirements remain high. The same sources indicated that the shortage of 2,000 bbl. per day in District 5 claims was probably due to military demands in the Pacific.

FOURTH QUARTER AUTOMOTIVE FUEL ALLOCATIONS
(Bbl. per day)

PAW District No.	PAW total allocation	Change from 3rdQ	To ODT	ODT change from 3rdQ	To WFA & OCR	Change from 3rdQ
1	383,000	—26,000	351,000	—13,000	32,000	—13,000
2	465,000	—49,000	383,000	+3,000	82,000	—52,000
3	146,000	+4,000	125,000	+5,000	21,000	—1,000
4	33,000	—5,000	29,000	0	4,000	—5,000
5	146,000	—1,000	125,000	+3,000	21,000	—4,000
Total U. S.	1,173,000	—77,000	1,013,000	—2,000	160,000	—75,000

Office of Defense Transportation Breakdown

	Total	Pass. cars	Trucks	Buses	Marine	Railroads
1	351,000	183,723	124,495	35,716	6,716	350
2	383,000	220,222	138,032	22,624	1,847	275
3	125,000	61,633	53,182	7,696	2,239	250
4	29,000	14,549	12,652	1,674	0	125
5	125,000	80,152	35,991	5,197	3,410	250
Total U. S.	1,013,000	560,279	364,352	72,907	14,212	1,250

Jennings, Sheets, Head Socony-Vacuum

NEW YORK. — B. Brewster Jennings was elected president of Socony-Vacuum Oil Co., Inc., last week, to succeed the late John A. Brown. Harold F. Sheets, vice president, was named chairman of the board, an office which had been vacant since 1935. Jennings, 46, has been with the company 24 years. Sheets has been in the company's service 37 years, 17 of them abroad.

Jennings graduated from Yale in 1920, after having interrupted his course to serve overseas with the U. S. Navy. He entered the marine department of Standard Oil Co. of New York as a clerk. After the merger with Vacuum Oil Co. in 1931 he became a director of one of the operating subsidiaries, and in 1936 was made assistant to President Brown. He was elected a director in 1937. In 1942 he received leave of absence to take charge of tanker operations for the Maritime Commission and War Shipping Administration, returning to the company last August 1.

Sheets has been a vice president since 1932, in charge of foreign trade. Abroad, he supervised the company's business in France, Spain, Italy, Germany, Belgium and Holland, with headquarters in Paris.

B. BREWSTER JENNINGS

HAROLD F. SHEETS

Forms Issued for Subsidy Reimbursement

WASHINGTON. — The Defense Supplies Corp. has finally begun distribution of report forms on which first-purchasers of crude oil may make claims for reimbursement for premium prices paid for crude produced from stripper wells listed for the subsidy by the Office of Price Administration.

The premium-price plan went into effect August 1 and reimbursement was due as soon in September as purchasers paid producers for their August production, but the necessary forms were not available until last week end.

Four forms are required, three to be submitted every month, and one to be filed only with the first claim for payment for oil purchased from a stripper pool. This latter form requires listing the production of each lease or property unit in the pool for the 12 months prior to the first claim for subsidy, but DSC will accept August claims without this form provided it is filed during October.

The three monthly forms are relatively simple and are said to be designed to include only information which crude buyers already have in their records. One simply states the amount of money claimed as subsidy for the month. The other two are supporting data.

More Rigs Needed to Sustain Drilling

WASHINGTON. — Drilling operations may level off at the current record levels during remainder of 1944 unless the number of new rigs made available to the industry each month is increased beyond present deliveries of 30 to 35 units. This prospect was reported here last week to the Petroleum Industry War Council in the report by the Production Division, Petroleum Administration for War.

The PIWC production committee's resolutions calling for release of total import and export figures on petroleum and for prompt reestablishment of adequate stocks of oilfield tubular goods in mill depots were later adopted by the general council. The resolution on import and export figures pointed out that restriction of this information prevents comprehensive analysis of domestic requirements and that suppression of these data are "no longer necessary to the security of the U.S. or the Allied countries."

Active rotary rigs increased to 1,634 in July and to 1,680 in August, the highest rate of drilling operations in history. The completion rate, however, is still considerably below the 1941 level. Total well completions in the first 7 months, PAW reports show, were 30.4 per cent above the same 1943 period but were 21.7 per cent under 1941. This condition exists notwithstanding the fact that total active operations as of August 1, 1944, were 50 per cent greater than at the same time in 1943 and only 4 per cent less than in 1941. The decrease in ratio of well completions to active rigs stems from increased well depths, material shortages and decreased efficiency of available manpower.

There were 481 geophysical and core drilling units engaged in exploration work August 1, an increase of 72 crews since first of the year. The type and number of crews active during July were: Seismograph, 290; gravity meter, 124; magnetometer, 17; core drill, 47; electric resistivity methods, 2 and torsion balance, 1.

Government Approved U.O.P.-Jap Dealings

WASHINGTON.—The War, Navy and State departments of the U. S. Government approved commercial transactions between Universal Oil Products Co., Chicago, and Japanese representatives in prewar years through which the Nipponese obtained engineering data and operating information on refining processes for manufacturing 100-octane aviation gasoline.

This official approval of U.O.P. relations with Japan was disclosed in a prepared statement by James S. Martin, chief of the Department of Justice's economic warfare section, who told a Senate military subcommittee of the U.O.P.'s action in making its files available to the department.

Haider Speaks Before A.I.M.E. Section

M. L. Haider, head of production, research and engineering for the Standard Oil Development Co., New York, was the principal speaker at the opening fall meeting of the Mid-Continent section of the A.I.M.E. at Tulsa, September 18. His extemporaneous discussion dealt with the Standard Oil Co. (New Jersey's) book on "Petroleum Reservoir Efficiency and Well Spacing". (See The Oil and Gas Journal, May 13, 1943. p. 55).

A spirited floor discussion followed Haider's talk, with most of the 90 members in attendance displaying intense interest in the subject. Stanley W. Wilcox, chairman of the Mid-Continent section, presided and the speaker was introduced by C. V. Millikan, chief engineer of the Amerada Petroleum Corp.

Letters:

West Edmond Reserves

September 13, 1944.

The Oil and Gas Journal:

Gentleman:

I have read your very interesting article in the September 9 issue about the West Edmond pool in Oklahoma County, Oklahoma. All of the information in the article is perfectly clear and very enlightening except that part which discusses the ultimate recovery.

The estimate of 4,000 bbl. minimum per acre recovery and 9,000 bbl. maximum per acre was arrived at according to the article by numerous geologists and company officials due to their knowledge and information available on every Hunton lime producing area in Oklahoma.

I am not familiar with the performance of the various Hunton lime producing areas in the State of Oklahoma, outside of West Edmond, but I am told that the wells in these various pools are producing from an average of 15 to 20 ft. of pay section and that they are producing from the Harrigan and Chimney Hill sections of the Hunton lime rather than the Bois d'Arc section of the Hunton lime and that they produce from a "structural concentration of oil," rather than a "stratigraphic trap."

If I have been informed correctly about these other Hunton lime producing areas, then it appears to me that it would be unreasonable to make a comparison between them and the West Edmond pool because the average pay section in this field will undoubtedly be approximately 50 ft. as against 15 to 20 ft. in the other Hunton lime producing areas — and the wells in the West Edmond pool are producing from the Bois d'Arc section of the Hunton lime which section is acknowledged to have considerably more porosity and permeability than the other two members in the Hunton lime—and it is generally acknowledged that the West Edmond pool is a "stratigraphic trap," rather than a "structural concentration of oil."

Assuming that it is fair for the numerous geologists and company officials to estimate the ultimate yield in the West Edmond pool on a comparative basis with the other Hunton lime pools in the State of Oklahoma, their ideas must be that the edge areas in the pool will recover so many barrels per acre and that next to these edge areas will recover a little more per acre, etc. In other words, certain parts of the field according to their ideas will have light recoveries and other parts will have big recoveries. Is this correct? If it is, then it appears that the most intelligent way to arrive at the recovery for any one lease or leases would be to estimate it on so many barrels per acre foot. By having this information, one could differentiate the recovery estimates from one end of the pool to the other.

As long as the information as to the recovery estimates in the article were obtained from numerous geologists and company officials, they no doubt made an estimate of the number of barrels per acre foot expected. If that is so, shall appreciate it very much if you will advise me what the estimates are in this connection and if they took into consideration the fact that the average thickness of pay section in the West Edmond pool will be around 50 ft. instead of 15 to 20 ft. as in the other Hunton lime producing areas in the State of Oklahoma and the characteristics of the Bois d'Arc section in comparison to the Harrigan and Chimney Hill sections and the type of structures.

Yours very truly,

Fort Worth, Tex. CHESTER IMES.

Editor's note.—It is true that West Edmond presents substantial variations from geological conditions existing in other Oklahoma Hunton pools, but such pools afford the only known basis for comparison and are used as such by all the larger operators. Furthermore, 6,000 bbl. per acre on 40-acre spacing is a substantially higher yield than the 7,000 bbl. per acre yield on 10-acre spacing estimated for the average "cream" of the other Hunton pools.

The "effective pay thickness" at West Edmond, as distinguished from the total thickness of the Bois d'Arc, is still an unknown quantity. Neither conventional coring nor reverse circulation has resulted in satisfactory recovery of the richest and most porous portions of the pay. On the other hand, some companies, after analyzing the cores recovered, and making high allowances for the missing portions, find the total so derived does not indicate acre yields beyond the range used in our previous article. Lacking definite information on porosity and permeability of the section from which the bulk of the oil must come, authoritative expressions of opinion on yields per acre foot of pay are simply absent.

The other major determinant in ultimate yield will be reservoir energy, and as there is no free gas cap and the oil is only about 75 per cent saturated with gas, the question is whether or not an effective water drive will develop. This is still an open question, although some of the data can be interpreted as not too promising. We realize there are bases for differences of opinion in the matters discussed in your letter. We appreciate your comments.

FOUNDED IN 1910

BY PATRICK C. BOYLE

the OIL AND GAS JOURNAL

Re: Future Demands

ECONOMISTS are making available studies covering the war and postwar conditions which will have an important bearing on future domestic and world demands for petroleum products. When they know definitely what the Allied needs will be with the conclusion of the German war and are advised of other governmental postwar plans, they will be able to resume the service of accurate projections of requirements.

Meanwhile there are controlling factors in the present outlook which do not require detailed analyses and which, if generally understood, should allay any fears as to what will happen in the petroleum reconversion period and later.

The current apprehension comes from the fact that many still insist on considering petroleum a war industry. As was pointed out on this page 5 years ago, when this global conflict got under way, the oil business owes its growth to the peaceful activities of mankind and wars have slowed down rather than increased the rate of expansion in world requirements.

For several years previous to 1939 the average yearly increase in world petroleum demand was about 100,000,000 bbl. Complete data have not been available since, but it is certain that world gains in petroleum demands from September 1, 1939, to date have been less than half the comparable prewar period.

In this country during the late thirties the average annual increase in domestic and export demand was approximately 75,000,000 bbl. This included the recession year of 1938, when domestic needs declined. Even with the peak military output of recent months in this country the growth for the entire 1942-44 period is only slightly greater than the prewar average and substantially less than the expansion during the booms of peace times. Without a war, demands for liquid petroleum in this country would have jumped to 5,000,000 bbl. daily during this year.

The primary task ahead is to bring about quickly these conditions which will enable nations everywhere to function normally when peace returns. GI Joe, as an average citizen, when he comes back to his job will require about the same quantity of petroleum he has had as a part of a war machine powered with petroleum.

In foreign areas, where 93 per cent of the world population lives and where petroleum consumption is half that of this country, the practice during the war has been to reduce civilian use to a minimum. The invaded countries of Europe, which before the war consumed approximately 400,000 bbl. of petroleum products, have gotten along with a small fraction of that total. That prewar market and others will be open to the world oil trade as soon as Germany capitulates. Remove the economies of those countries from the shadows of war and war preparations and their petroleum needs will quickly double. The U.S.S.R., forced to stop its program of industrial and agricultural expansion to get ready for this war, will rapidly strengthen its position as the second largest petroleum-consuming nation when peace arrives.

Thus the main reconversion job of the petroleum industry is not to find new markets to offset war losses. Its principal task is to make the greatest possible use of war facilities and rid itself and its customers of governmental war controls so that both can resume their normal activities as suppliers and consumers.

Shock of Early Postwar Oil Decline Centered on Texas

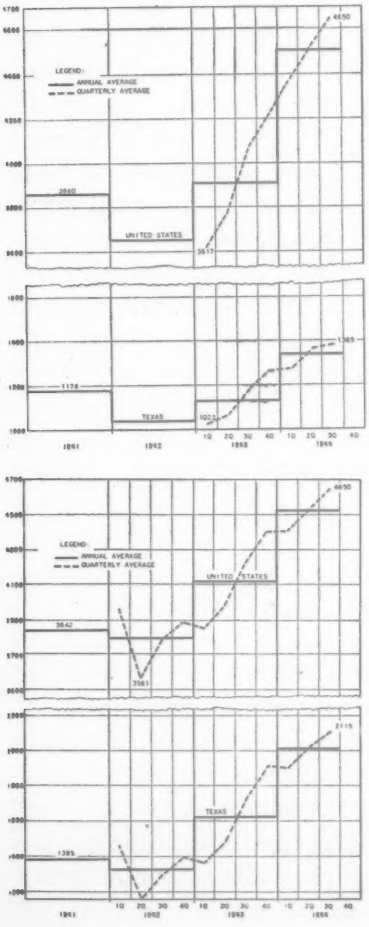
by Richard J. Gonzalez*

Forepart of this paper presented before the Gulf Coast section of the A.I.M.E. at Houston, September 12 dealt with the record petroleum operations of Texas in supplying war demand. This published portion deals with the postwar aspects. The author reports that military consumption of petroleum products supplied by the United States exceeds 1,250,000 bbl. daily. First shock of decreased military demand on VE Day, he concludes, will be absorbed by Texas.

THE very magnitude of changes in petroleum operations in Texas since 1941 is an indication of the serious postwar readjustments that will occur. It is inevitable that Texas will experience a very substantial decline in petroleum operations after the war in Europe ends, and a further shock when the war in the Pacific is concluded. While the shock of readjustments incident to termination of the European phase may be partly cushioned for the petroleum industry by larger civilian consumption and by some additions to stocks, there will still be a serious decline in operations.

*Economist, Humble Oil & Refining Co.

Postwar readjustments in the petroleum industry may be simplified by additions to stocks, or they may be complicated if stock accumulations are too rapid or too large. U. S. petroleum stocks of 473,000,000 bbl. on July 1, 1944, were 90,000,000 bbl. lower than at the beginning of 1941, but only 29,000,000 of this draft occurred east of California. It will not be necessary to restore stocks to the 1941 level in order to achieve efficient operating conditions after the war when demand declines, but even if the stocks were increased 29,000,000 bbl. east of California, that would allow an addition of only 40,000 bbl. per day for 2 years or 80,000 bbl. per day for 1 year. Such additions to stocks as occur in California will influence production only in that area, due to transportation difficulties and price differentials involved in moving oil to the Pacific Coast. Under these circumstances, production east of California at a rate substantially in excess of demand in the transition or early postwar period would create serious problems. It is necessary, therefore, to consider the changes which will be required to balance supply with demand.



Left: Refinery crude-oil runs to stills. Lower left: crude oil production. Lower right: Natural gasoline, condensate and benzene production. (All figures in thousands of barrels)

Estimates of the decrease which may occur in military requirements when the war in Europe ends can only be in the nature of speculation at this time. It has been indicated that there may be a decrease of 40 per cent in war production when the war in Europe ends. If this ratio were to apply for petroleum, the decrease in military requirements of the United States would be at least 500,000 bbl. daily. This might be accomplished by lower petroleum consumption incident to war production, such as fuel oil for industry and railroads and gasoline for trucks and buses. To offset these declines, additional consumption of petroleum products by civilians might be permitted.

Civilian Increase Appraised

It does not appear likely that the increase in civilian use of gasoline in the near future would exceed 200,000 bbl. daily if all restrictions were lifted outside of the Pacific Coast area (PAW District 5). It is estimated that there are about 20,000,000 passenger cars now in use in the United States, excluding those in District 5. The average consumption per car is now about 6 bbl. less than the high average in 1941. If it were assumed that all cars could immediately return to the average consumption in 1941, the increased civilian demand would be 120,000,000 bbl. per year, or 380,000 bbl. daily. Due to the greater age of the cars, however, as well as to mechanical and tire troubles, it does not seem likely that consumption would be increased immediately by more than half of this amount. Increased use of fuel for heating might be more than offset by lower industrial use. Under these circumstances, the net gain in civilian use of petroleum may not exceed 200,000 to 250,000 bbl. per day when the war ends in Europe. This would fall short of balancing the lower military demand by 250,000 to 300,000 bbl. daily, depending upon the extent and pace of military operations in the Pacific and the amount con-

sumed in military activities other than those on the fighting front.

The decline in demand will be reflected almost entirely on Texas in so far as crude oil production is concerned, since it has supplied the additional oil for military purposes. A reduction in outlet for Texas crude of 250,000 bbl. daily after the war in Europe ends is probably conservative. For some months the demand may drop considerably more than this average. After the war is entirely concluded, crude oil production may be expected to drop to about 4,000,000 bbl. daily for the United States and to 1,500,000 to 1,600,000 for Texas. While this production may appear low in relation to current levels, it would still be substantially higher than the prewar record levels of 3,840,000 for the United States in 1941 and 1,400,000 for Texas in 1937.

The petroleum industry in Texas faces serious readjustments when the war ends. The fact that the decline may represent 15 per cent on the operations for the United States does not mean that the adjustment can be made readily. The concentration of these adjustments on Texas may well mean a maximum decline of 25 per cent in crude oil and refinery operations after the war. The difficulties incident to achieving such reductions are readily apparent. It can only be hoped that the industry will deal with these problems as soundly and effectively as it handled others in order to establish its remarkable record for supplying the additional oil required for war.

Higher Recovery Predicted for Horizontally Drilled Wells

FRANKLIN, Pa.—When the 24 horizontal wells comprising the installation of Venango Development Corp. at Two Mile Run, near here, have been completed and got down to settled production they will yield as much oil per acre in 1 year as vertical wells, at the 1940 rate, could recover in 50, according to expectations of Leo Ranney, technical adviser in the project and inventor of the drilling method used.

With only 10 acres of the 400-acre tract subjected to gravity drainage by these Ranneywells during the 180 days ending September 2; with only one of the wells now producing shot, and with 15 points of vacuum applied to the installation for only the past 20 days, production in this 6-month period has averaged 28 gal. of oil daily per acre tapped. This is 56 times as much as was produced daily by the vertical wells on the lease, under 25 points of vacuum, pumping 24 hours per day, in 1940 and 1941.

During the 20 days after vacuum was applied, production increased, Ranney said, although the full value of the increase has not been accounted for yet.

Under 21 points of vacuum the horizontal wells are delivering 126 times as much oil per acre daily as the vertical wells, under 25 points of vacuum, produced in 1940.

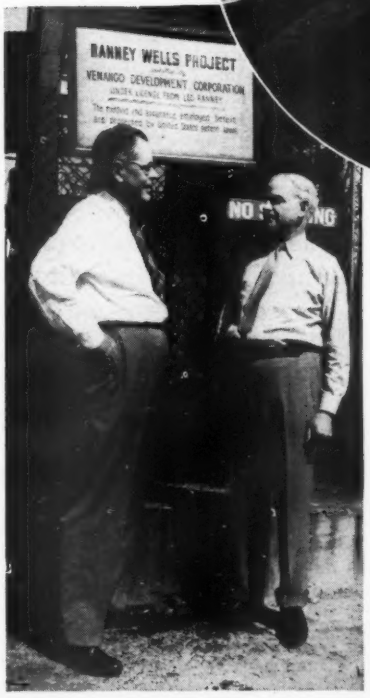
The 400-acre lease of Venango Development Corp. has been producing oil 20 years, during which the recovery has totaled 640 bbl. per acre. This is an average of 8 bbl. per acre annually, or less than 1 gal. per acre daily. In 1940 and 1941, the years taken by Ranney for comparison with the horizontal wells, the production of the 400 acres amounted to 1,800 bbl. annually, or about ½ gal. per acre daily. Some 100 wells were drilled on the lease, one to each 4 acres.

"In secondary recovery of oil, the number of barrels per day produced is less important than the recovery cost per barrel and the rate of recovery, as compared with the methods previously employed," Ranney said.

"If horizontal wells had been drilled initially, the 80 years' production on this lease could have been obtained in less than 2 years. The horizontal wells have produced as much oil per acre in 6 months as would have been recovered by vertical wells, at the 1940 rate, in 28 years. And the horizontal wells pass within 10 to 100 ft. of several old vertical wells where, presumably, the sand has been fairly well stripped of oil.

"To compare with the vertical-well development on the 400 acres, only one pump will operate the 24 wells radiating from the shaft, and this will be operated by one man, pressing a button. The cost of multiple powers, shackle rods, vacuum lines, flow lines, jacks, sucker rods, cups, working barrels, pumps and the expense of pulling and cleaning will be eliminated. It is anticipated," Ranney continued, "that 1 year after completion the 24 wells will settle to a total production of 240 bbl. per day.

"The actual cost of producing oil from the old vertical wells (averaging about ⅛ bbl. of oil and 5 bbl. of water per day) exceeded $3 per barrel. In operating the horizontal wells, allowing $15 per day for wages, $5 per day for upkeep, $200 per month for power and $100 per



Right: Ben Harris, project manager, watches flow from pump line. Below: Robert E. Allen, director of public relations, American Petroleum Institute, and Leo Ranney, conversing at the Venango Development Corp. horizontal well

month for contingencies, the field lifting cost will be under 15 cents per barrel. Deducting the one-eighth royalty, leaving a net of 210 bbl. per day, the net income of the property at the present price of the oil ($4.38 per barrel) would be $880 per day or $321,000 per year. Without the 75-cent subsidy the net (at $3.63 per barrel) would be $730 per day or $266,000 per year.

"Under normal conditions, in spite of the difficult drilling, the entire cost of the Franklin project would be approximately $500 per acre. By the time one-fourth of the wells in such a project are completed, the net value of the oil currently sold will be more than sufficient to carry the development to completion.

"In considering the horizontal-well figures, it should be borne in mind that this property has produced only 8 bbl. per acre per year for the past 80 years. Better results could be expected in a field where the sand has been more productive. The Franklin heavy oil has a viscosity (Saybolt) of 280 at earth temperature, contains no gas, gasoline or kerosene. The only natural expulsive force is gravity, which would be much more effective on oil of lower viscosity. However, this Ranneywell should enjoy a long life.

Roller Bits Successful

"In previous Ranneywell installations in the first Cow Run sand in Ohio, bortz diamond bits were used exclusively. In that softer sand, with no pebbles present, often a bit would cut from 200 to 300 ft. of hole at the rate of 100 ft. per shift. But in the first Venango sand at Franklin, containing many lenses of pebbly quartzite, even black diamonds would often wear off in drilling 3 ft. The relatively high cost led the project manager, Ben Harris, to try roller bits, the net result of which was a 50 per cent reduction in drilling cost. The rate of drilling a 4-in. hole depends upon the hardness of the rock at a given point. In spots where the Franklin formation contains no large quartz pebbles a run of 50 ft. per shift is often obtained.

"The cost per foot of drilling 4-in. horizontal wells has now been reduced, even in this hard rock, to a figure comparative with drilling, casing and equipping vertical wells, However, if vertical drilling is reduced to a basis of cost per foot of productive formation tapped, the comparison is much different. For example, if a vertical well 1,000 ft. deep penetrates 20 ft. of oil sand, and the complete well costs $3,000, then the cost per foot of productive sand is $150. In a horizontal-well installation the cost of equipping (with pump and flow lines) and casing (100 ft. of pipe being used in each well) amounts to about 10 cents per foot of hole in a 50,000-ft. development from one shaft.

"The two most important factors to account for the low cost per foot of oil sand exposed are these: The method of two-at-a-time drilling, where the drill rods are shuttled from one drilling well into the opposite drilling well (without uncoupling the rods); and the fact that all 52 weeks of the year are spent drilling in the oil sand, as against 1 or 2 weeks of the year that the vertical driller spends in the producing formation.

"In the Two Mile Run development horizontal wells Nos. 1 and 2 were drilled to 2,234 ft. and 2,355 ft., respectively — approximately to property lines—and 3,900 ft. of these wells were shot on Thanksgiving Day, 1943. Necessary hollow rods for cleaning these wells and drilling additional holes were not obtainable until March 1944. Then the shot wells were cleaned out, some 3,000 cu. ft. of sand being removed by gravity; but they could not be put on full production until pumps arrived in August. Then an unplugged old vertical well, discovered near No. 1 horizontal well, was found to be flooding the flat well with upper fresh water. The offending well is now being plugged, while No. 2 horizontal well is on production, under vacuum.

"To provide oil to help carry the cost of development it was decided to start drilling the 24 wells around the circle to a depth of 1,000 ft. and to place them on production, unshot, as soon as completed. When this is done, each pair of opposite wells will be extended to property lines, with only one pair of drilling wells off production at any time. Four additional wells have now been drilled to the 1,000-ft. length and are being placed under vacuum. It is estimated that shooting the wells increased production about 40 per cent so at least alternate wells eventually will be shot."

General American Acquires Barnhart Field Properties

DALLAS.—General American Oil Co. of Texas, with headquarters in this city, has bought the producing properties of R. H. Hawn and San Andres Production Co. in the Barnhart field of Reagan County, West Texas. The holdings are in Sections 1, 2, 8, 9 and 10, Block 48, University Survey. The reported consideration was $900,000 cash and $300,000 oil.

DEATHS

Louis H. Benner, 60, general traffic manager for Socony-Vacuum Oil Co., Inc., died September 9 in New York. Benner started his oil career in 1907 with Standard Oil Co. of Kentucky, went to New York in 1911 as head of the traffic department of the old Standard of New York, and when that organization and Vacuum Oil Co. were merged in 1931 he was named to the post which he held till his death.

Fred E. Glendering, 49, drilling contractor, of Salem, Ill., died September 8.

Eugene W. Cookenboo, 27, independent oil man, died September 12 in Houston. For 8 years he was in the land-lease department of American Republics Corp.

Carl C. Kizer, 58, assistant treasurer of Lone Star Gas Co., died September 14 in Dallas. He had been in continuous service of Lone Star and one of its component organizations, Dallas Gas Co., 37 years. He was treasurer of the Dallas company when it was merged with Lone Star in 1943.

Charles M. Staigers, 86, pioneer operator in Pennsylvania oil fields, died September 8 at his home in South Pasadena, Calif. In his later years Staigers did geological work, and his operations covered Oklahoma, Texas, Louisiana, Kansas, Kentucky and Ohio.

Gus Ninkovitch, 58, superintendent and director of Doyle Petroleum Corp., died recently in Taft, Calif. He had substantial oil interests in Kern County, California.

Walter H. Weed, 82, geologist, of Pasadena, Calif., died September 8. Educated at Columbia University, he was in the service of U. S. Geological Survey from 1883 to 1906.

Clair Wilhelm, production foreman for Shell Oil Co., Inc., at Oilfields, Calif., died recently.

Leslie C. Mingus, 59, production superintendent for I. L. Dunn, Tulsa, since 1912, died September 14. He was widely known for his ingenuity in the improvement of repressuring methods from pioneering stages to their present wide application. Interment was at Chester Hill, Ohio, near the first compressor station which he built 32 years ago for a repressuring project of Cumberland Oil Co. and continuously operated since then.

William M. Schaill, 64, for the past 18 years associated with the Gulf companies in Colombia, Venezuela and New York, died September 15 in New York. Since 1906 he had been active in exploration, drilling and management of oil properties in South America. He was one of the original investigators of the Barco concession.

PIPE LINE *Section*

New Construction Methods Developed for Laying Big Pipe

by Paul Reed

Back hoes of Bechtel-Dempsey-Price digging ditch in steep mountains of eastern Kentucky

CHANGES coming rapidly into pipe-line construction, particularly for big-inch lines, mean that in the handling of certain phases of work the industry is getting away from practices long regarded as standard. In retrospect several years from now, 1944 is likely to be regarded as a significant period of transition in the evolution of pipe-line-construction technique. Radical as some of the new devices are, even more radical departures now being discussed and devised must be reckoned with in the near future.

Among those developed in the last few years which have arrived at their fullest application so far in 1944 are pressure welding, cold machine bending and line up with the internal hydraulic clamp.

Of the several big-inch lines of 1944, including those of Cities Service Gas Co.'s 26-in.; Stanolind Pipe Line Co.'s 16-in.; Pacific Lighting Corp.'s 16-in., 18-in. and 22-in.; and Kansas-Nebraska Natural Gas Co.'s 18-in., the one which has afforded the opportunity for observing the application of modern methods under the most varied conditions is the Tennessee Gas & Transmission Co.'s 1,266-mile system from Corpus Christi, Tex., to Cornwell, W. Va., being built of 24-in. pipe with the exception of 85 miles of 20-in. at the eastern end. Contractor's operations were contacted for the preparation of this article at sections laid by Bechtel-Dempsey-Price, Williams Brothers Corp., Midwestern Engineering, Ray L. Smith Construction Co., and N. A. Saigh Co.

Lowering in by Williams Brothers Corp. close to lake crossing in Mississippi near the Mississippi River

Difficult Terrain

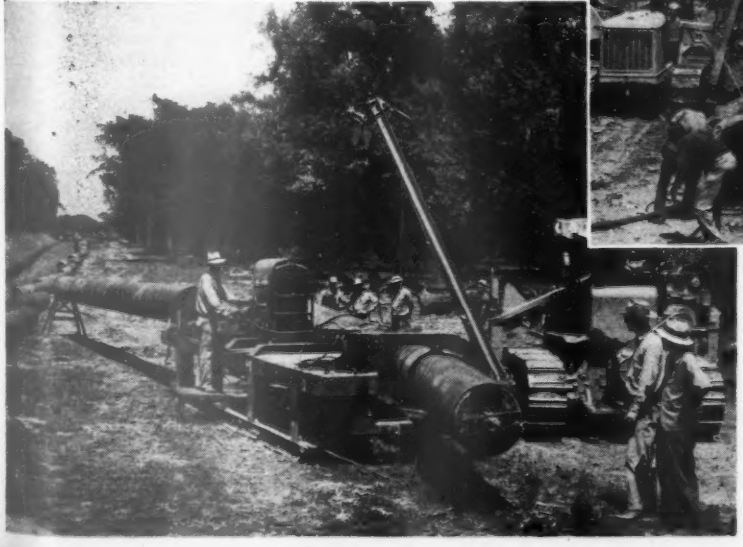
Going eastward along the route, operations of Bechtel-Dempsey-Price were first visited in the rugged terrain of eastern Kentucky where it was necessary to lay the line directly up the sides of very steep mountains where there were numerous cliffs, many of which had to be graded to provide a usable right-of-way. Pipe-stringing trucks could move only by being towed by tractors. Much winching and towing has been necessary for handling the contractor's equipment on the mountain sides.

This work demonstrated that no country is too rough for pipe-line construction. Considering the terrain it is remarkable what a small percentage of the ditch was dug by

Big Sandy River crossing being laid by Midwestern Engineers seen from the West Virginia bank looking toward Kentucky

hand and how most of it was being excavated by heavy power-driven, mechanical equipment such as ditchers, back hoes, and drag lines. On extremely steep slopes ditch was being dug frequently by bulldozers. Because of the amount of hard rock, numerous large-capacity air compressors were employed in preparing for blasting. In this section the rate at which ditching advanced determined the progress of the whole spread.

Away from the mountains, this contractor was also laying across rough rolling country of the lowlands where the operation of the interesting Elliott-Price inside line-up clamp could be observed in an area where it was important to carry on welding as expeditiously as practicable. This hydraulic clamp, which brings pipe to correct roundness and spacing by a mechanism operated entirely inside the pipe, permits welding the first bead without interference by any obstruction. The introduction of this device this year has attracted wide attention of the industry. Its operation and results are described in another article in this issue.



Above: Line-up and bell-hole welding of Bechtel-Dempsey-Price in Kentucky. Left: Bending machine on N. A. Saigh Co. spread in Texas

Operations of Williams Brothers Corp. were observed in the rough wilderness of Tennessee as well as in the lowland country of Missis-

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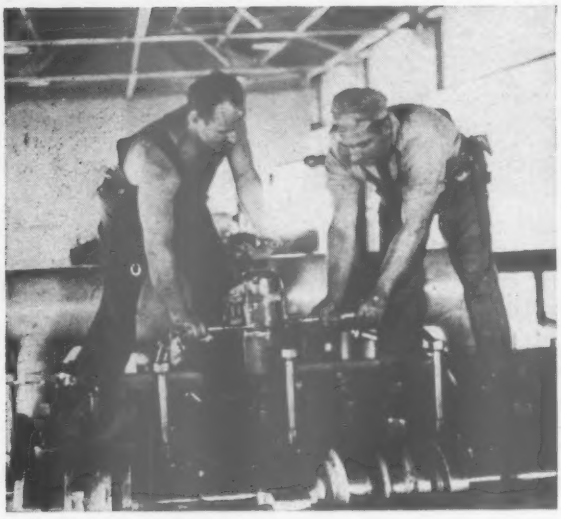
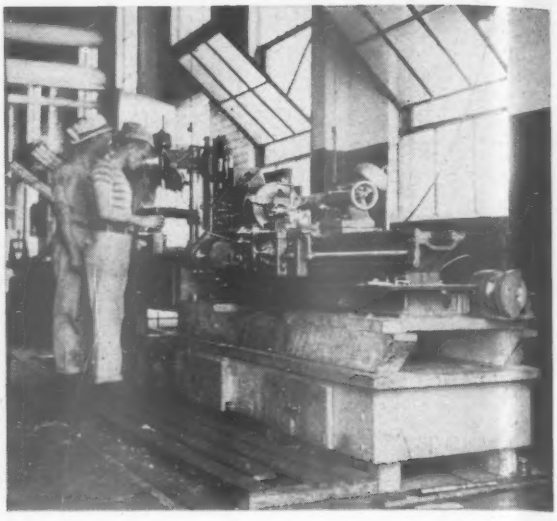




Overhaul operations of traveling crew are speeded up by (left) pneumatic impact wrench doing a job within a few minutes which ordinarily takes an hour, and (right) lathe and drill of mobile machine shop

Methods and Equipment for Wartime Pump-Station Maintenance

by J. Delbert Jones*

THE advent of World War II brought about, among other things, the necessity to move large quantities of crude oil to the Atlantic seaboard. This sudden demand for increased capacity brought many changes in the pipe lines serving that area. Reserve pipe-line capacity and spare units disappeared overnight. Engines were operated at speeds and capacities that before the war were not considered possible for any length of time. Shutdown time for repairs was reduced to a minimum and in many cases the methods of making routine repairs were completely altered in order to obtain the maximum flow of oil. Many changes were made in the maintenance program of the Gulf Refining Co.-Tulsa Pipe Line division trunk system between Jenks, Okla., and Dublin, Ind.

This system consists of 12 stations, each with identical equipment. During normal times all the repair work was carried on by taking advantage of weekly shutdown periods supplemented by periodic overhaul periods that reduced the pipe-line capacity during such work. Such arrangements were adequate in normal times when men, parts, materials, and transportation facilities for men and materials were available. The requirements of the war effort brought about the necessity of operating this system at full capacity at all times. It was, therefore, necessary to devise some means of carrying on the maintenance program that would reduce the shutdown time to a minimum.

*Master mechanic, Gulf Refining Co., Tulsa Pipe Line Division.

Mobile Maintenance Crew

The method now in use involves the use of portable pumping units and the maintenance of a full-time mobile maintenance crew, fully equipped to carry on the usual overhaul work with a minimum of interruption in the regular station operation. The portable units are of such capacity as to allow the main units to be withdrawn from service one at a time for overhauling. Two portable units are used in order to gain a certain amount of flexibility in operation and to facilitate the handling of this equipment during moving periods. The portable pumps are 6 in. by 12 in. Gaso pumps powered with 200-hp. Buda motors operated as diesel engines. Inasmuch as these units are moved on an average of every 30 days, special consideration has been given to features that would increase the portability and reduce the time required to put in operation at each station. The engines are equipped with light-weight, demountable hoods and side covers that can be quickly removed or installed as the case may be. The arrangement of fuel-oil and lube-oil filters and other accessories is such that operating difficulties are reduced as much as possible. The manifolds for the two pumps are prefabricated so that the units are set up alike at all stations and it is only necessary for adjustments to be made in the length of the suction and discharge lines. The two engine-fuel tanks are of such capacity as to take the full load of the conventional-size transport truck. These tanks are mounted on welded pipe frames of truck-bed height that are easily knocked down and set up at each location. The portable units are completely overhauled after a trip over the system. Minor adjustments are made during the moving period when the units are out of service.

The repair crew consists of a foreman and a crew of usually 20 men. Each man is skilled in his work and is usually highly specialized in a portion of the work to be carried on. The main unit is completely dismantled along with all auxiliary

Two portable 200-hp. pumping units with portable fuel tanks function to uphold throughput during overhauling

equipment and all necessary replacements and adjustments made. To meet wartime conditions, the crew has been supplied with equipment not commonly found in such work. In fact the crew is almost a selfcontained mobile machine-shop organization prepared and equipped to do everything that is ordinarily required during an overhaul of the mechanical equipment at a pipe-line station. For example, the crew has a 13-in. by 42 in. LeBlond regal bench lathe mounted on special skids and equipped with such accessories as three-way and four-way chucks, face plate, taper attachment, grinding and milling attachment. In addition to all this, the machinist has made special jigs and mandrels that enable him to make repairs to certain fuel-pump valve parts and other engine parts quickly and easily. The use of such jigs and mandrels greatly reduces the time formerly required to make such repairs. The lathe is extremely useful in making repairs to parts that otherwise might be discarded either because of lack of local facilities to make such repairs or the lack of transportation facilities due to local conditions. Small parts can be made out of discarded materials without the usual delay in finding a machine shop that is not engaged in war work and one that has the time to do such odd jobs. Protection for the lathe during moves is provided by means of a waterproof reinforced cover. A bench drill equipped with a full range of drills and an angle vise has proved to be one of the most valuable pieces of equipment furnished the crew.

Another piece of equipment not ordinarily found in pipe-line stations is a pneumatic impact wrench. This wrench is equipped with enough various-sized sockets so that all of the heavier parts of the engine can be easily dismantled. When using the former method of sledging the head nuts off, it is necessary to strip the head of all valves, studs and service connections in order to make room to use the head wrench. Now it is possible to remove the head nuts with most of the valve mechanism in place, thus allowing the work to be either carried on quickly or at a more convenient time. When the pneumatic wrench is being used as it is by this crew, it is economical both in time and manpower. When it is desirable to loosen and tighten the cylinder-head nuts in performing such operations as pushing in a liner with the cylinder head or to remove the cylinder head on an emergency job, the impact wrench saves time as well as enabling one man to do a job that normally requires several men. Some jobs formerly requiring an hour's time and two men sledging the nuts can now be done by one man in 5 minutes with the impact wrench.

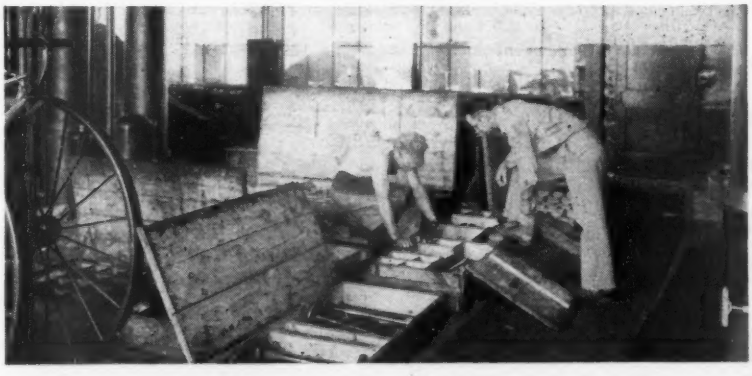
Light and heavy-duty hydraulic jacks, along with all accessories are provided for such tasks as pressing off couplings, pushing out liners, and other similar jobs. A 1-ton electric hoist is provided in the engine room in addition to the regular station cranes. This light-weight hoist is attached to the regular crane I-beams and provides means of handling engine parts easily and with dispatch. The various members of the crew have devised rather ingenious methods and means of doing their various tasks. The counterbalanced valve grinder and the portable bench with special features for holding bearings while they are being scraped in are typical examples.

In order to make as sure as possible that all spare parts be on hand, the crew carries along with them a stock of the most frequently used parts. This affords maximum use of the available supply of parts on hand and saves frequent delay in obtaining parts from some other station. A clerk travels along with the crew to handle all materials, time, and other clerical duties.

A light truck equipped with an "A" frame is used by the crew in handling most of the heavy parts outside the station building and to assist in the loading, unloading, and setting up of the portable equipment. Electric and acetylene-welding outfits are provided to build up worn out parts when such repairs are feasible, as well as to assist in the connection work in setting up the portable units.

Spare assemblies of certain parts of the engines, such as fuel pumps, are swapped out and repaired during slack periods of the overhaul. Repair to the heavier parts of the machinery, such as bearings, is performed by shops specializing in such work. Advantage is taken of the overhaul shutdown period to either install new equipment or make alterations. For example, at Strang, Okla., station, air filters were installed on all the main engines' air intake lines.

This method of overhauling has made maximum use of a minimum amount of portable equipment, parts, and manpower. The absence of frequent interruptions attributed to mechanical difficulties and the high capacity maintained by the trunk system speaks well for the method of overhauling and the work done by the overhaul crew.



Delays in obtaining parts are eliminated by carrying, in convenient boxes, a large stock of parts with the traveling crew

Lowering in line in mountainous country of Wyoming

TREND IN PIPE-LINE PRACTICES

by William G. Heltzel

This survey of the status of pipe-line design, construction, and operation is published in two parts, second part of which will appear in next week's issue

Coating and wrapping Stanolind Pipe Line Co. crude-oil line from Elk Basin to Casper, Wyo.

ALTHOUGH this article is devoted principally to trends in engineering and operating practices, a brief reference to some economic trends, at the beginning, may be of interest, because they may have an important influence on the crude-oil pipe-line industry.

Long strides of progress made in recent years signalize new practices in a virile and dynamic industry that may have a bright future, depending largely to what degree its progress may be thwarted by conditions beyond its control. Here at home the growth of the pipe-line industry, expressed in miles of lines, may not be as phenomenal as in the past. But that does not mean that the industry has reached its zenith and will become static. Its growth and progress in the future (measured to a lesser degree by miles of lines) will be gaged by improvement in practices, greater tonnage and diversification in its traffic. After the war the building of petroleum-products distributing systems will be resumed and the crude-oil pipe-line systems will be extended to reach new and more remote sources of supply. The movement of petroleum products by pipe line forecasts a greater use of this method of transportation for a broader variety of liquids. In the postwar period when a world-wide search for oil is resumed, a new chapter in the history of the industry will begin. Many miles of pipe lines will be built in foreign lands, reaching even to the frontiers of the world. American pipe-line engineers, seasoned in knowledge and experience, will play a major role in these developments. And the American oil companies, construction contractors, and manufacturers of equipment should be

in the lead in these undertakings.

Viewed from its own potentiality, the industry is in a healthy state and its outlook appears bright; however, economic and political factors beyond its control may have an important influence on its nature and character in the future. Frequently an industry becomes so accustomed to the ways and the practices of the past that it does not recognize and respond to new circumstances. Alertness is helpful in meeting tendencies. If and when evidence is irrefutable, it is worthy of recognition. Of course, it is futile for any industry to try to thwart or halt economic forces beyond its power to retard or stop.

Regulations for the conservation of petroleum, economic limitations, and the trend in the design of pipe lines are forces that may determine the nature of the crude-oil pipe-line industry in the future. Their effects cannot be fully discerned at this time. Under the conditions of war, they have been arrested and obscured. Undoubtedly, these unrelenting forces will continue unabated; however, their lagging consequences may be so gradual that a change in character and a transition in practices may not be easily and promptly recognized. Let us consider the effects of these various factors which cannot be gainsaid. Regulations for the conservation of petroleum mean more gradual development, lower rate of production, higher ultimate recovery, and a longer life of a field. The wide-open production that required the overbuilding of pipe lines, both as to number and capacity, witnessed as recently as the Seminole, East Texas, and Illinois fields, is history that very likely will not be repeated again. The result may be fewer but larger pipe lines and less duplication of gathering systems. Economic limitations add their effects. The earnings of crude-oil and petroleum-products pipe lines are now and will probably continue to be limited. The trend in tariffs has been to lower rates. And the public urge is always toward better products and service at a cheaper price. The combined effect of these economic forces deter the risk and venture, inherent in the nature of the business, that is bound to result in caution and conservatism with respect to investment in new pipe lines.

As discussed in detail subsequently, the new pipe-line design is toward larger-diameter lines, meaning also larger-volume pump stations, which are much more economical than a number of smaller lines having an equivalent capacity, both as to first cost and the operating expense. This type of pipe line will be used in the future for long hauls. Undoubtedly, it will become a competitive factor with respect to tariffs.

It is indefinite now what the outcome will be. The influence of the various forces discussed above, evidenced in some of the pipe lines built recently, should become more apparent in the nature of new facilities after the war. It is reasonable to believe that in the future new oil regions will be served by fewer pipe lines, but that these will be of larger diameter and greater capacity. There may be less duplication of facilities, especially in the gathering systems. From this digression on matters of a general nature, our thought turns now to the theme of the article.

Trends in Designs

In previous articles written during the past 12 years, the author has expressed the opinion that in designing new pipe lines, the trend would be to larger diameters, thinner walls, higher tensile steel, and increased operating pressures. These factors are well established in modern designs. Also, up-to-date pipeline engineering provides for different weights of pipe (telescopic design) in accordance with the pressures under which sections of the line will be operated. Longer distances between relay pumping stations are becoming more prevalent. There is a trend to less or no storage tanks at relay stations. The author believes that in future designs a "reserve capacity factor" should be included by providing for reserve strength in the manifold piping, in the high-pressure ends of lines, and in the pumps, and also by flexibility and adaptability for greater capacity in the pumping machinery.

Larger Lines

Foremost in the recent trends has been the adoption of larger-diameter pipe for long trunk lines, as witnessed in the 16-in. line of Gulf Oil Co. laid in Venezuela in 1939, the 20-in. and 24-in. lines of War Emergency Pipelines, Inc., built in 1942 and 1943, from Texas to the Atlantic Coast, and 385 miles of 16-in. built from the Slaughter field, West Texas, to Drumright, Okla., by Stanolind Pipe Line Co. during the winter of 1943-1944. The successful use of 20-in. and 24-in. pipe on the War Emergency Pipelines' project was a courageous undertaking that will be referred to later. The 20-in. and 24-in. sizes were used to meet the exigencies of our nation at war. The supply of steel, badly needed for war implements, was critically short. Dire circumstances demanded the earliest possible completion of a pipe-line system that could deliver 500,000 to 550,000 bbl. of crude oil and petroleum products daily. The shortage of steel required that the design provide for the maximum capacity per ton of steel. This was discussed in detail in the author's article in The Oil and Gas Journal, September 18, 1941. The big-inch (24 in.) and the little big-inch (20 in.) were justified as wartime measures.

Such large diameters may be used to some extent in the future for crude-oil transportation, when sufficient oil (equal to the capacity of

(Continued on page 273)

Applying priming coat with automatic equipment during construction of Stanolind Pipe Line Co.'s Elk Basin-Casper, Wyo., line

Protecting Pumping Equipment From Fire Damage

by C. M. Rosebrugh *

GULF REFINING CO., on its products-line system pump stations, has installed a system for quick water displacement of all pumps, pump suction and discharge lines within a station in case of fire, in order to protect the pumping equipment.

This is accomplished by connecting the pump suction manifold outside the station building with a source of water. Beyond the station pump discharge manifold, some distance from the building, a main-line check valve is installed. Between this and the station a dump line leads to a receiving pit, some 500 ft. from the building.

In case of fire, the pumps are left in operation and the pump suction manifold water connection is opened, the oil suction cut off and the dump valve opened. The dump line relieves all pressure on the station pumps and facilitates the quick displacement of pumps and lines. All valves are located a safe distance from the building and are arranged for convenient and quick manipulation.

*Chief engineer, Gulf Refining Co., Houston Pipe Line Division.

In July 1943, Project 5—El Dorado station, consisting of reciprocating plunger pumps driven by diesel engines, caught fire at one of the pumps and burned down part of the station building.

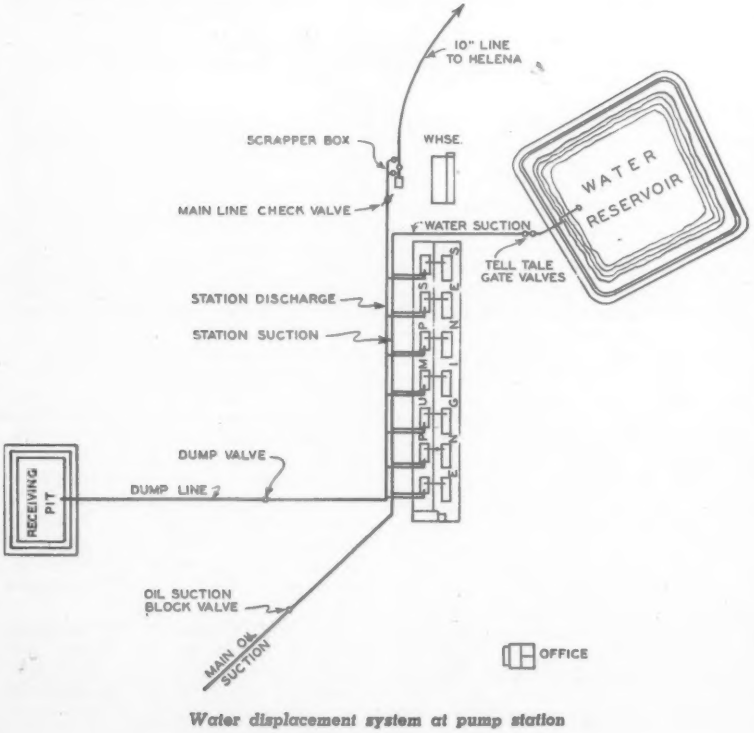
When this station was built, it was considered necessary to provide for water displacement in the operation of the line, and consequently the station pump suction manifold was connected to a water line from the cooling-water reservoir. When the fire started, the chief engineer cut in the water suction and closed off the products tank, with the pumps still running and operating at line pressure. After the displacement of the pumps and lines with water, the fire source was eliminated and damage to the equipment was of a minor nature, quickly repaired.

Reduction of Damage

In this instance the manipulation of valves and operation against line pressure caused some delay in getting complete pump displacement, and the roof and part of the station-building walls were burned before the fire was finally out. A delay of 4 days in getting the station back on the line was caused by clearing away of building debris for safe operation of the machinery. Principal repairs to the pumps consisted of rebabbiting pinion and crosshead bearings on one pump.

After this experience, it was realized that a dump system as now installed could have caused displacement of lines and pumps quickly enough so that fire damage to the building would likely be of a minor nature and interruption in operations cut to a minimum. Since the rare occurrence of pump-station fires is generally caused by the ignition of the crude or products within the station pump room, the quick displacement of lines and pumps not only removes the source of additional fuel to the fire, but the movement of water through the pumps until fire is under control carries away the heat and leaves the equipment, for the most part, in running order and in shape to be gotten back on the line quickly.

El Dorado, Ark., station building of Project 5 line during construction



Water displacement system at pump station

AUTOMATIC-CONTROL INSTALLATIONS —for Natural-Gas Pipe-Line Systems

by Earl Kightlinger*

TEN years ago a gas consumer was satisfied simply to have gas available; now he demands that the pressure on his line be maintained constant. He also demands that proper measurement equipment be installed to accurately measure his load during all conditions. The fact that the customer's minimum load is only a very small per cent of his peak load is seemingly of no consequence and not considered a problem.

One of the large-town border meter installations serving a city of about 150,000 had as its only source of regulation, when originally installed, a 16-in. gate valve manually operated during the entire 24 hours. That method of regulation is far removed from the present regulator installation which automatically boosts the pressure at the inlet of the city system to hold a steady pressure of 20 lb. at a central point on the intermediate system.

The basic design of regulators is such that with changing inlet pressures and loads, the outlet pressure cannot be controlled as closely as needed for efficient operation of all stations. The actual installation of automatic controls must be based on the judgment of the design engineer as to whether the additional cost necessary to secure more accurate measurement or control is advisable from an over-all financial and operation standpoint.

During 1939 the practical methods committee of the Southwestern Gas Measurement Short Course assembled a report on "Pilot-Operated Regulators." This report included the various types of pressure controllers built by manufacturing companies and several adaptations of pilot-operated and pilot-controlled regulators that are more or less home made. These home-made controls have, according to their users, been relatively satisfactory.

The accompanying pictures show a few typical installations of various type controls. Fig. 1 shows a typical setup used at high-pressure gasoline plants. In the operation of the gas field the wells are set on a steady volume while the pressure on the gasoline inlet is held at a predetermined pressure, generally around 400 lb. With this control method, if an additional well is put on in the field the back-pressure valve opens and allows more gas to flow into the pipe-line system and holds the plant operating pressure steady.

Fig. 2 is a typical setup for a gas-distillate wells being flowed into a gathering system on the inlet of a gasoline plant. With this setup, the gas and distillate go into a separator where the gas is carried out of the top and through an orifice meter while the distillate is measured through a positive meter. The operation of the positive meter depends on a snap-acting control operated by the fluid level in the separator. By using a spring-closed motor valve any failure of the control will cause only a buildup of distillate in the separator. When using a spring-opened motor valve the control failure would let gas pass through the liquid meter and cause excessive wear.

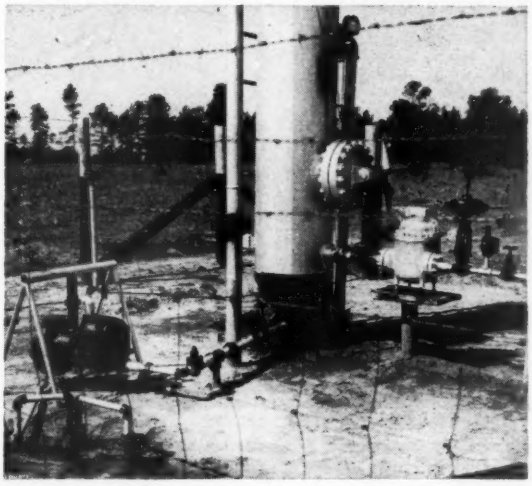


Fig. 2: Gas-distillate well, showing liquid meter and control

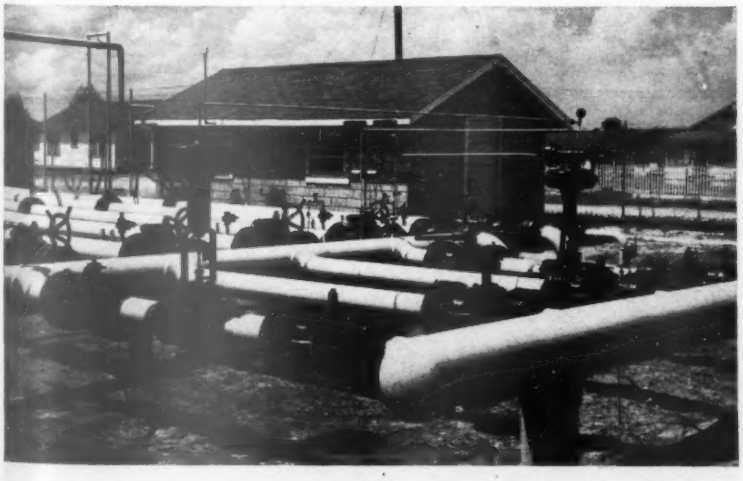


Fig. 1: Back-pressure regulators at the gasoline-plant discharge manifold

Fig. 3 is a typical multiple regulator station serving a large industrial consumer. The consumer requires a constant pressure of 50 lb. for plant operation. An indirect-acting pressure controller is connected to a diaphragm motor lever which is in turn connected to the lever arm of the regulators. The two 6-in. regulators are connected to one control and the 8-in. regulator to the

*Superintendent gas measurement, pipeline department, Arkansas Louisiana Gas Co.

other control. As one control is set about ½ lb. below the other, an accurate reduced pressure can be held at all load conditions. The auxiliary weight hangers prevent a complete regulator shutoff even though more than the desired controlled pressure might be applied to the diaphragm of the motor lever in case of failure of the pilot supply pressure.

Fig. 4 shows a metering arrangement using a differential limit controller to place in service an additional meter run when the differential on the primary meter nears the limit of its range. Both orifice meters are wide range installations using a combination of a 20-in. meter and a 50-in. 50-lb. meter. The meter on the left is the primary meter and in service at all times. Below this meter can be seen a portion of the built-in differential limit control mechanism. As the differential reaches a predetermined point, generally about 80 inches, the automatic control releases the pressure from the diaphragm of an open and shut motor valve on the secondary run to the dual setting. Gas will flow through both runs until the differential is low again, approximately 10 in., at which time the control will again allow supply pressure to be placed on the diaphragm of the motor valve and all gas will pass through the primary meter. This control can also be used on a positive and orifice meter combination if desired.

Fig. 4 also shows, on the wall at the extreme right, the sending mechanism for the town border station previously mentioned as having at one time been controlled manually by a 16-in. gate valve. The power plant at this location is in the center of a city and must have at the regulators a steady inlet pressure of 20 lb. The pressure at the plant is also dependent on the pressure drop due to the other commercial and domestic load and it may at times be necessary to have a maximum of 45 lb. or a minimum of 21 lb. to hold the desired 20 lb. Although this pressure change may come within a period of 45 minutes, the automatic long-distance control is able to supply the required pressure boost. The mechanism as shown sends over about 4 miles of wire the pressure at the central point. The receiving mechanism furnishes the necessary supply pressure to motor levers attached to three 6-in. regulators and either increases or lowers the pressure on the outlet of the regulators sufficient to hold the desired pressure at the central point.

At one town border station it is desired to feed gas into the city system at 90 lb. until the main line drops to 120 lb. and then holds a back pressure of 120 lb. on the main line allowing the town pressure to drop to 88 lb. at which time a control attached to a regulator on another line controls the city pressure. This is accomplished by both a back pressure and a reducing-pressure control and their motor levers attached to the primary regulator serving the city plant.

In another location a large consumer is fed directly from a gasoline plant with the volume consumed being balanced as near as possible by the field input. It is necessary that the pipe-line pressure near the consumer's plant be held at a minimum of 160 lb. To prevent excess pressure or low pressure on the line when the consumer load varies from 5 to 10 million cubic feet per day, a dual regulator setting has been installed to feed into and from the line. By the use of two sensitive controls it is possible to take care of the consumer and prevent an excessive pressure from getting on the line.

Quite a few home-made controls having a pilot-loaded diaphragm are used but on this installation care must be taken to prevent a shutdown due to failure of the pilot supply which would close the regulator valves. When regulators are pilot loaded it is possible to use a much larger diaphragm than when the same regulator would be weight or spring loaded. By the use of the larger diaphragm more sensitive regulation is possible.

Automatic controls when properly used can be of immense value to the gas dispatchers in operation of their pipe lines by holding pressure closer than at all possible by ordinary regulators. The chart calculations are also made easier and more accurate by a straight-line pressure. Many other automatic devices than those mentioned may be profitably installed. A necessary precaution in installation of any automatic equipment is that regardless of what happens to the automatic controls, safety precautions must be provided to insure a flow of gas to the consumer even though the pressure may be temporarily increased or reduced.

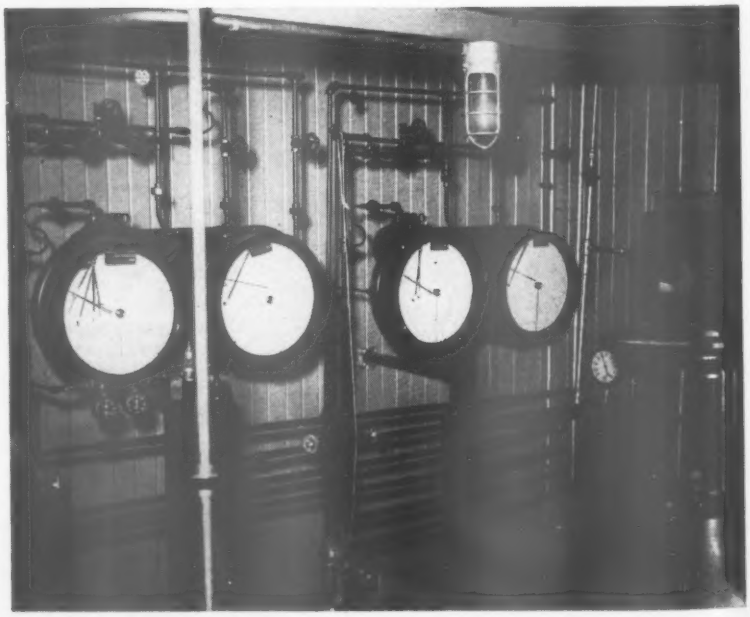


Fig. 3 (above): Controls for multiple regulator station. Fig. 4 (right): Differential control mechanism and long-distance control

PRACTICAL SUGGESTIONS

Centering Gasket While Applying Pipe-Line Patch

FOR overcoming a difficulty in applying a patch to stop leakage from corrosion pit holes, A. G. Grant, mechanical foreman, Shell Oil Co., Inc., pipe-line department, Tracy, Calif., has devised a method by which precast lead gaskets may be more rapidly and conveniently centered. To the concave side of a patch, a small steel wire is attached in a position perpendicular to the patch surface. This is done by inserting the end in a shallow drilled hole where it is held by center punching. A precast lead gasket, perforated in the center, is slipped over the wire. By inserting the wire in the leaking pit hole the gasket is accurately centered quickly. The chain clamp is then applied compressing the gasket against the pipe to stop the leak. After this the patch is welded.

Counterweight for Valve Grinder

TO facilitate operations while engines are overhauled a counterweight has been used to lift the electric valve grinder so that it will be in a convenient position when not in use. The cable connecting the valve grinder with the counterweight runs through two pulleys on the walkway between diesel engines which make it possible to place the counterweight where it will not cause inconvenience.

Portable Work Bench for Overhaul

AMONG the items of portable equipment carried from one crude-oil pump station to another by the traveling maintenance organization is a work bench which has special equipment for holding main bearings of 6 by 18 reciprocating pumps. At the side is a convenient board for holding tools needed in pump overhaul operations.

Tennessee 1,265-Mile Pipe Line and Stations Approach Completion

by Paul Reed

THE steady progress to meet the construction schedule of Tennessee Gas & Transmission Co. for building the 1,265-mile system from Corpus Christi, Tex., to Cornwell, W. Va., is indicated by the status of the project on September 5. With the exception of 85 miles of 20-in. at the eastern end, the entire line was built of 24-in. pipe. Up to that time 1,085 miles had been welded, 1,047 miles lowered and 1,042 miles backfilled.

Complete and detailed information regarding the design and construction of this great project, which is the largest natural-gas transmission system built in recent years, will not become available for publication until November when the line is in operation.

Gardiner Symonds, president of Tennessee Gas & Transmission Co., announced the system would be completed October 1 and gas would be transmitted October 15 to meet delivery schedules calling for 287,000,000 cu. ft. daily to supply vital war industries in the Appalachian area. If testing operations require less than 15 days the line would be in operation earlier.

Final cleanup had been completed for 543 miles. Purging had been finished and valves had been installed for 190 miles. And final testing at 800 lb. pressure had been done for 63 miles.

Stovepiping such as this in Kentucky has been generally used this year in laying 24-in.

To expedite testing of the entire line by gas pressure the management arranged to have natural gas furnished at both ends of the pipe line and the middle. Where gas was not available from the company's own sources of supply, connections for the testing periods have been planned for natural-gas transmission from the systems of other companies.

The initial compressor station and the dehydration plant at Corpus Christi had been finished, all of the piping has been pressure tested and only cleanup work remained to be done. Construction operations had been carried to a point at the stations at Monroe, La., Batesville, Miss., and Lobellville, Tenn., where it would be possible to operate. Stations at East Bernard, Tex., Jasper, La., and Campbellsville, Ky., were nearly completed. All stations on the line were far enough advanced to be regarded as 85 per cent finished.

In pipe-laying operations Williams Brothers Corp. had completed the work of five spreads working in Louisiana, Arkansas and Mississippi and was laying at the rate of a mile a day on the last 14 miles of its section in Texas which would wind up the 400 miles contracted by this firm.

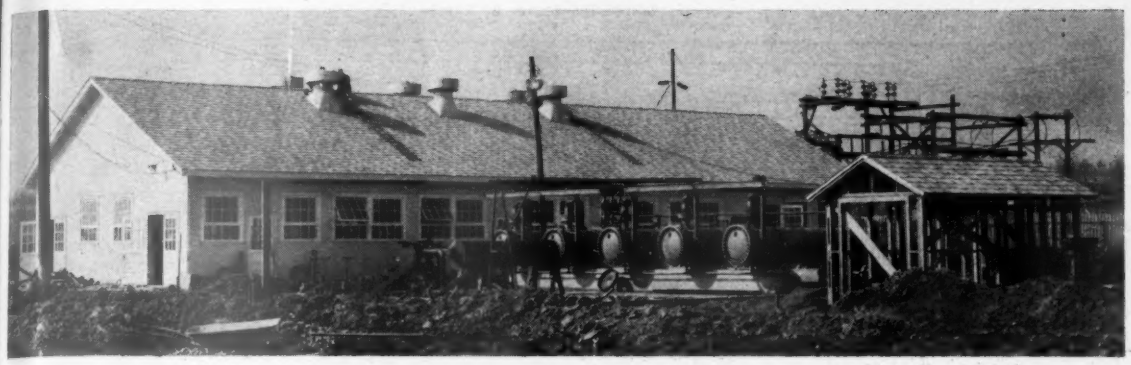
N. A. Saigh Co. had finished 119 miles and was moving one of its two spreads to another section in Texas. In Louisiana Ray L. Smith Construction Co. with 62 miles and Midwestern Engineers with 64 miles were making good progress toward the end of the sections they had contracted.

With the finish of its 38 miles in West Virginia in sight, Pipe Line Construction Corp. was moving some of its equipment west to another section. Operations were reported to be approaching the final stages for J. R. Horrigan Construction Co. with 62 miles in West Virginia, Bechtel-Dempsey-Price with 321 miles in Kentucky, and Brown & Root, Inc., with 124 miles in Texas.

Laying of river crossings by several contractors and the erection of aerial bridges east of the Mississippi River by Austin Co. and west of it by Pittsburgh-Des Moines Steel Co. were estimated to be 85 per cent completed.

Chicago Corp. and Gulf States Oil Co. will supply Tennessee Gas & Transmission with gas for the line. At the West Virginia terminus the output will go to Hope Natural Gas Co. of Clarksburg and United Fuel Co. of Charleston, W. Va.

The total cost of $54,000,000 includes $16,000,000 for pipe, $8,000,000 for seven compressor stations, $2,000,000 for right-of-way, $2,700,000 for river crossings, and $200,000 for a dehydration plant.



View of station under construction. Note finished appearance of main building and framework for sample house

Shortages Force Station Designers to Employ Ingenuity in Construction

by Lewis F. Scherer*

RESTRICTIONS in the use of steel and certain other building materials brought about by wartime shortages have forced designers to a study of problems which had become somewhat routine. No longer was it possible to order a factory-designed or prefabricated steel building to suit the particular needs of the location; to order a steel sump tank to the necessary specifications or to design concrete walls and floors on the basis of adequate steel content. Standard steel doors and window sash and steel substation racks became a fond memory and the problems of fire hazards assumed a new importance.

These problems were of course solved in many ways; some by using makeshift and temporary construction; some by the trial-and-error method, but in many instances a sincere attempt was made to provide as sound and permanent construction as the limitation of available material afforded. This article will discuss primarily methods of construction which were found to give satisfactory results under trying conditions of material, labor and weather and where utility and the time element were permanent.

Unique Applications of Materials

The first application of the restriction of materials found many pipe-line companies either starting or about to start construction of much-needed additional facilities. Lack of specific knowledge and the need for hasty revision resulted in many unique applications of available material.

The construction of pump houses was of primary importance and where large diesel units were to be installed this posed a major problem. Cranes and craneways were required and spans had to be greater than would normally be considered good practice for wood construction.

Fortunately, not many buildings of this type were necessary and most companies were able to salvage or transfer and reerect existing buildings. In some cases old steel trusses, rafters, and craneways could be salvaged from brick or concrete buildings no longer needed. These trusses were then mounted on columns made of second-hand line pipe, gusseted, braced and tied together in the field by welding

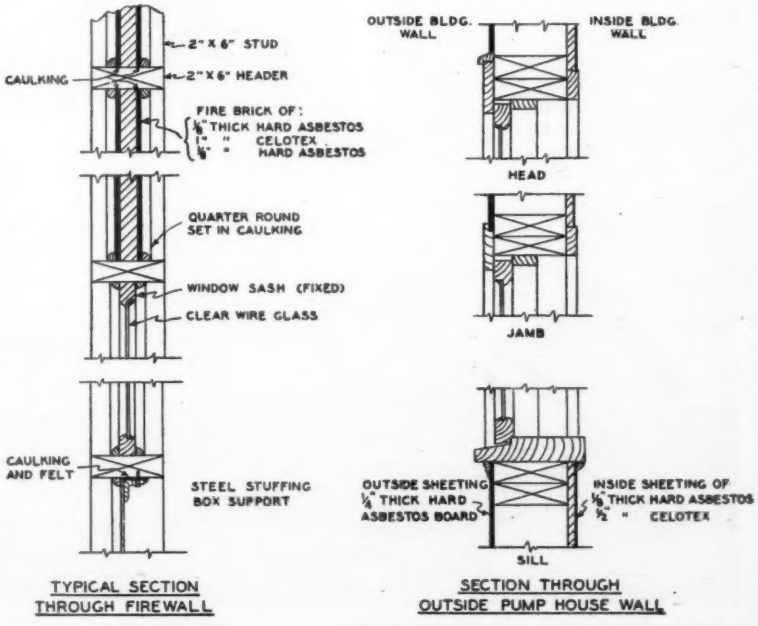


Fig. 1

*Assistant chief engineer. The Texas Pipe Line Co.

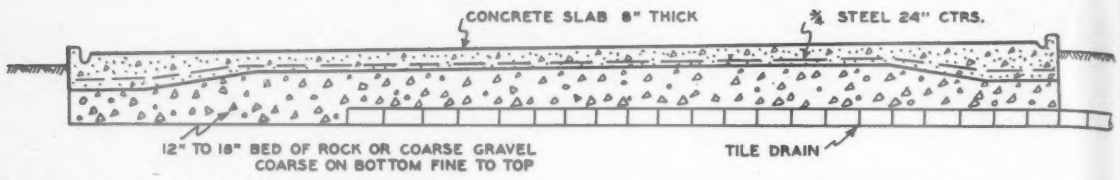


Fig. 2: Section through slab and base, showing construction to minimize effect of soil changes using minimum amount of steel in slab

Junk sucker rods were used for the ties and when available, second-hand angle iron was used for the supporting framework for the windows and the corrugated asbestos siding and roofing. In some instances this framework had to be of wood which was bolted on to lugs welded to the pipe columns, When corrugated asbestos or second-hand corrugated iron was not available, flat sheet iron salvaged from wood-roof tank tops was used as siding and roofing.

Gratifying Results

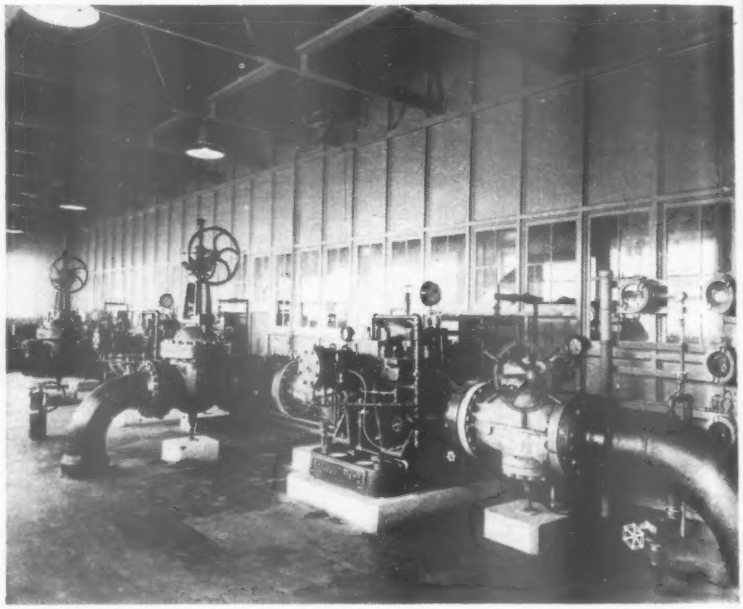
To discuss all the details of such construction would not be practical as every building of this type was a problem of its own. These buildings are isolated instances of the industry's ingenuity of doing the best it could with the material at hand, and surprisingly enough, the results in most cases were gratifying.

When it become necessary to construct a considerable number of buildings housing essentially similar equipment, widely separated geographically and built by a number of different contractors, many new problems were involved.

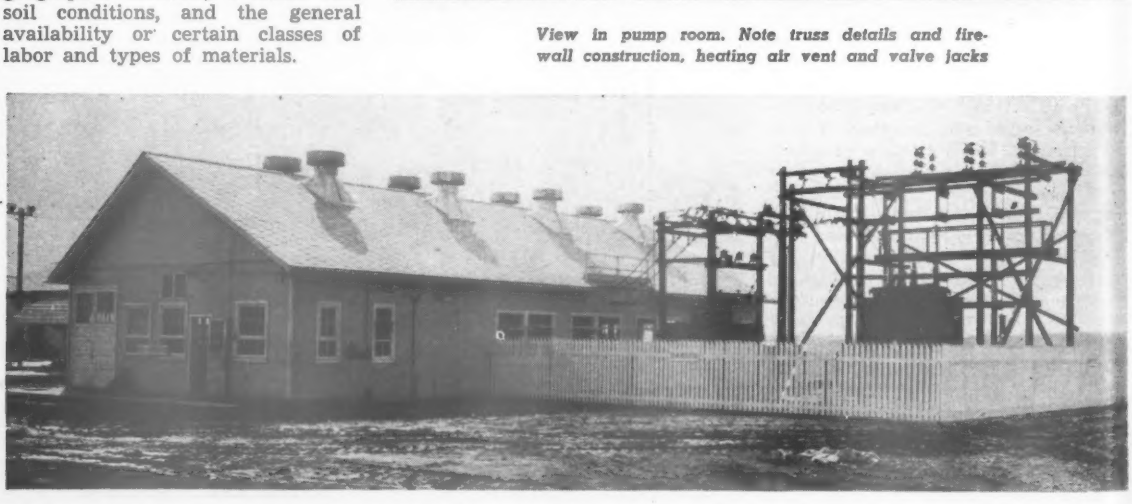
To decrease the engineering work, the ordering and shipment of materials and to give due consideration to the maintenance problem of the future, it was necessary that the design of such buildings be standardized throughout the system. This involved a knowledge and study of geographic location, climatic and soil conditions, and the general availability or certain classes of labor and types of materials.

In the case of War Emergency Pipelines, Inc., geographical variation was from the Texas Gulf Coast to the Atlantic seaboard; climatic conditions varied from the semi-tropic, humid swampland to Allegheny Mountain tops; soil conditions included loose sand, gumbo, quicksand, loam, swampland, loose rock, clay and limestone. The type of building construction adopted in this instance seems to fit the conditions imposed and is well within the limiting wartime restrictions in so far as the use of critical materials is concerned.

The pump house proper is framed with 2-in. by 6-in. lumber throughout with double plates on top and bottom of studs, reinforced corners and double framing around the openings. The trusses too, are of 2-in. by 6-in. timbering with bolted ring joints. Stud spacing and open-



View in pump room. Note truss details and fire-wall construction, heating air vent and valve jacks



Transformer yard. Note rigid construction, wood picket fence, safety and snow guard over power cables and louvers under eaves

Typical control room. Note removable panel, air pressure vents in ceiling louvers in door, gas-tight firewall and electric circulating heater

ings are laid out to accommodate standard 4-ft. by 8-ft. sheets of hard asbestos board. The fire wall is of continuous 2-in. by 6-in. studding extending from the foundation to the ridge, with headers spaced to support inlet panels of fireproof material. Parallel rafters between the trusses support the matched wood sheeting for the asbestos shingle roof. These details will all be discussed later.

A continuous-footing-type wall of ample proportions to support the building load was used as the foundation. The depth was varied somewhat to suit ground conditions, but other dimensions were standardized to permit reuse of the forms at several locations. Because of a lack of reinforcing steel (except in a few locations where scrap was used) the foundations were poured monolithic. By taking care to see that the footings were well filled out and rammed before the wall section was poured and by using continuous pouring and vibrating of the forms this method results in a substantial and reasonably strong wall. Holddown bolts for the building framework were inserted in the top of the wall before the concrete set. The fire-wall foundation was formed in the same manner and poured at the same time.

All framing was precut to size with power saws and the walls assembled on the ground and erected into position by sections. The use of the new steel-wood windows simplified this framing detail and of course made the windows easily replaceable with steel sash when such material becomes available. Their use also permits a simplified, inexpensive and neat-appearing trim.

Truss members were cut to dimension with a power saw and the parts stacked in handy position to an assembly jig. All joints were made up with the patented metal ring joint and assembled with bolts in this jig. This procedure results in greater uniformity and a more finished appearance. Full-length timber was seldom available and where splicing was necessary the splice was of the butt type, reinforced on each side with a batten of the same stock with the bolting extending through all three members. By doubling the upper chord members, bolting the braces between them, with the lower end of the braces meeting in a common point on either side of the lower single chord; the assembly held together with a single bolted ring joint at each point, a very simple and rigid truss was constructed. Either or both of the upper chord pieces may be extended beyond the wall line to form lookouts for the cornice. With this design the wall sections and the trusses are sufficiently rigid that they can be raised and positioned with an extended "A" frame in a pipe-line winch truck.

The trusses are tied together at the ridge with a continuous 2-in. by 8-in. and by setting the trusses on approximately 6-ft. centers and alternating them with a 2-in. by 6-in. rafter, ample support is provided for the 1-in. by 6-in. matched decking. The decking is covered with a layer of 15-lb. asphalt-saturated asbestos felt and hard asbestos shingles are then nailed to the decking with a 4½-in. exposure to provide a substantial weatherproof and fire-resistant roof.

The construction of a fire wall without the use of critical material is something of a problem. Brick or tile construction was ruled out because of the transportation expense of the materials and the difficulty of obtaining the proper skilled labor. A combination of lumber and asbestos insulating material properly caulked will result in a gas-tight wall which will be fairly fire resistant. A section through such a wall may be seen in Fig. 1.

Wall Material

In the construction of this wall 2-in. by 6-in. studding is set on 25¾-in. centers, the studding extending from the lower plate to the ridge. Horizontal headers of 2-in. by 6-in. are spaced at vertical centers of 4 ft. by 1¾ in. This arrangement permits the use of standard 2-ft. by 4-ft. sheets of insulating board and 2-ft. wide sash the length of the wall above the pumping unit shafts. Fig. 1 showing a section through the wall indicates the method of construction. The quarter round on one side was first nailed in place—a heavy bead of caulking was applied in the angle; the insulating board was then inserted, caulking run around the periphery and the holding quarter round nailed in place.

The pumping-unit shafts are extended to go through a specially designed stuffing box, which is supported by a frame fabricated of ¼-in. steel plate and angle iron and framed into the wall. The arrangement permits easy access to the motor or pump-shaft ends by dismounting the stuffing box or if more space is needed, removal of the entire supporting panel without breaking into the wall. Fixed sash glazed with clear wire glass was framed into the wall above the unit centerlines to provide a clear view throughout the pump house.

In cases where the motor controls and switch gear are to be kept separate from the pump and motor rooms similar construction may be used for this wall, with large panes

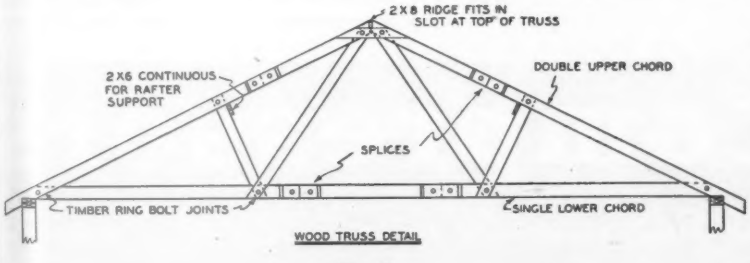

2X8 RIDGE FITS IN SLOT AT TOP OF TRUSS
2X6 CONTINUOUS FOR RAFTER SUPPORT
DOUBLE UPPER CHORD
SPLICES
TIMBER RING BOLT JOINTS
SINGLE LOWER CHORD
WOOD TRUSS DETAIL

Fig. 3

G·MV..... The 10

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One of the Biggest Reasons is EFFICIENCY

Cooper-Bessemer G-MV compressors are picked for heavy-duty jobs in all parts of the country because they combine the space-economy of 2-cycle, "V" design with exceptional ruggedness and a fuel efficiency in a class with 4-cycle performance.

HERE ARE TEN OF THE REASONS FOR THE G-VM's HIGH EFFICIENCY:

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5. *OIL-COOLED PISTONS*—Oil under pressure flows continuously through enclosed chambers under the piston crowns, eliminating preignition, piston distortion, stuck rings, and permitting minimum piston-to-cylinder clearance.

6. *SILENT SCOT FUEL INJECTION*—Unusually precise injection timing is combined with a fuel port design which directs fuel toward the spark, assuring complete combustion, regular firing at low loads, and greater fuel economy.

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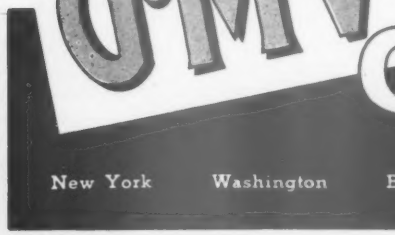
8. *AUTOMATIC CONTROLS*—Cooper-Bessemer pioneered in the development of a number of outstanding compressor control systems to meet all operating requirements. Any number of engines can be controlled simultaneously over 100% variation in demand.

9. *FULL-PRESSURE LUBRICATION*—For maximum efficiency, full pressure lubrication is provided at all main, crankpin, piston pin, crosshead and auxiliary drive shaft bearings. If desirable, different lubricants may be used for power and compressor cylinders.

10. *DUAL LUBE OIL FILTERING*—A full-flow, pressure-type oil strainer filters all circulating lube oil. In addition, a portion of the oil is continuously de-sludged and acidity is neutralized in a second filtering system.



Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

of clear wire glass inserted to give a view into the engine rooms. A control room so arranged across the end of the building with a view into both pump and motor room permits the use of less expensive open-type control equipment. As an additional safety factor this room may be maintained under slight pressure by ceiling in under the trusses and mounting a blower fan in the trusses to draw in fresh air from outside and force it into the room through properly located vents. Pressure may be regulated with vents let into the lower panels of the outside doors of this room.

For comfort of the operations it might be well to consider insulating the side walls and ceiling with a suitable insulating material between the studding and rafters. The ceiling may be neatly paneled with standard 4-ft. by 8-ft. sheets of hard-asbestos-faced celotex. The joints may be covered with battens or if the work is neatly done, the joints may be caulked to give a smooth ceiling.

The inside and outside of the outer building walls may be surfaced as shown in the section through a sash mounting (Fig. 1). The framing is so arranged as to take standard 4-ft. by 8-ft. sheets of the siding material. A heavy bead of caulking material is applied to the studding at which the sheets are joined. The sheet is laid on the caulking, fitted and nailed in place with the adjoining sheets. The excess caulking material is forced out through the joint and readily removed with a putty knife. After painting, this results in a smooth tight joint and battens are not needed. The use of ¼-in. thick hard asbestos sheets for the outside of the wall and ½-in. celotex surfaced with ⅛-in. thick hard asbestos on the inside results in a weatherproof, vermonproof, and well-insulated wall reasonably fire resistant and suitable for either cold winter weather or humid summer weather.

To facilitate the placement or removal of switch gear usually necessitates the installation of an oversize door. Such a door is usually difficult to keep weathertight and where large switch-gear units are used in a separate control room, their appearance would be out of proportion. The construction of a removable panel in the side wall or end wall of the building adjacent to the gear is a more satisfactory solution. When this removable panel is to be installed in the side wall a heavy timber transom is framed into the desired opening to support the truss. The removable section is separately framed to fit the opening and is well braced internally. Both sides are sheeted as is the building wall and key bolts or blocks are affixed to the sill and the lower edge of the panel. Outside battens are affixed to the panel and inside battens to the fixed wall. With the removable panel in place screws are used to fasten the outside battens to the wall and the inside ones to the panel.

When sufficient height cannot be obtained on the outside wall such a panel can be built into the end wall by building a trussed transom of 2-in. by 8-in. on edge. "I"-bolts built into the panel at the proper locations permit handling with a pipeline winch truck.

Suitable roof ventilators should, of course, be used on both pump and motor side. These may be augmented by louvres built into the side walls just under the eaves with slide-door closures built into them on the inside.

Where large electric motors are used for pumping, the cooling air from the motors may be carried up to the roof ventilators in ducts thereby facilitating the cooling of the motors and resulting in a more comfortable motor room. Where winter heating is necessary a small booster blower may be installed in this ductwork and the latter modified to permit delivery of this heated air to the pump room through a standard tank vent-type flame arrester mounted in the fire wall.

Construction methods similar to those used for the main pump house may be used with equal success for small outside buildings such as sam-

Jeeps

helping on the home front, too

Like their brothers on the battle fronts, our jeeps are performing excellent service in the construction of this vital pipe line. As part of our regular equipment, they are used by Superintendents, Foremen, Timekeepers, etc., in making their rounds over the rough, rugged right-of-way . . . helping to finish the job ahead of schedule.

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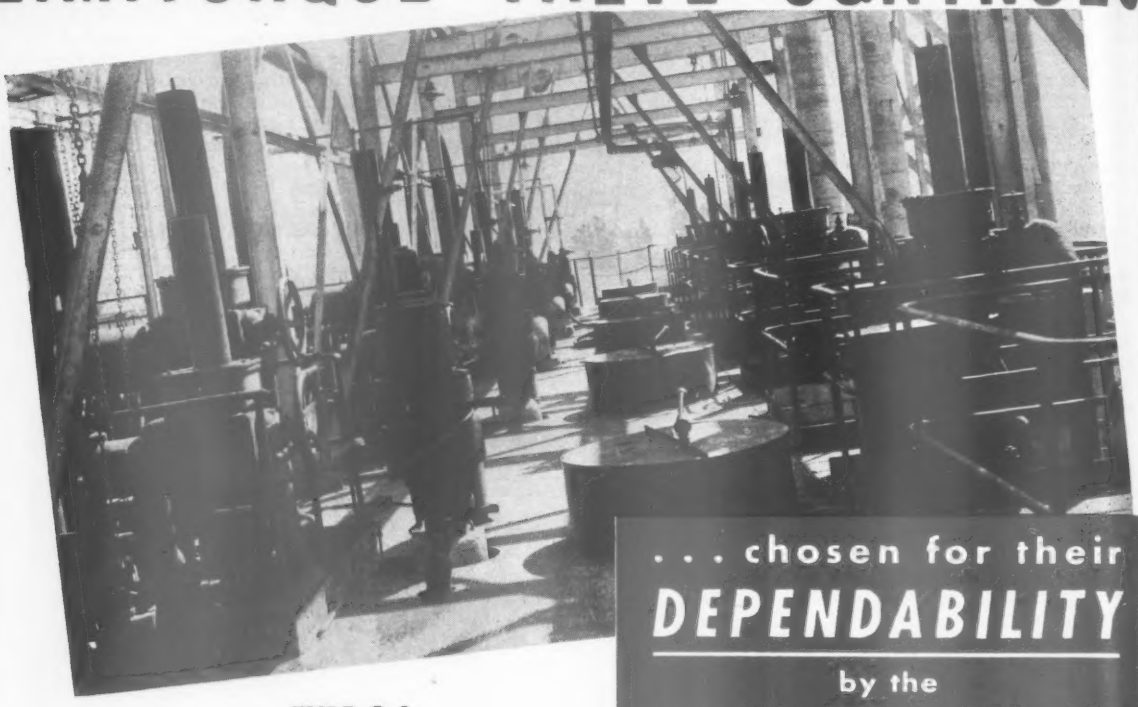

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and over 90% of all other 100 Octane Gasoline Plants

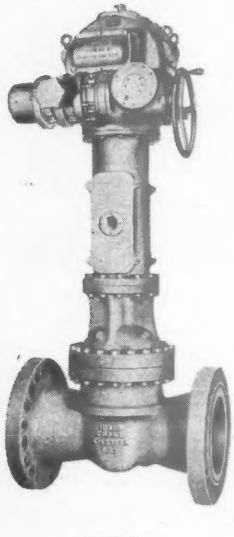
The photograph above illustrates a large group of Type O.S. LimiTorque Controls installed in the hydroformer plant of the Oleum Refinery of Union Oil Company of California. It is typical of the great many installations of these valve operators, where the dependability of the controls to function for long periods without maintenance or repairs was a most important factor in their selection. The design of the LimiTorque Controls permits high speed operation, thus assuring maximum production.

TYPE O.S.

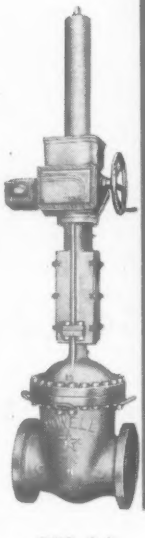
This type unit is designed for mounting on top of the valve yoke flange. It consists essentially of a motor driven combination helical and worm gear reducing mechanism with limit and torque switches in a rugged, weatherproof and dust-tight housing. Can be used on valves up to 96" diameter.

TYPE S.C.

The crank type mechanism employed enables it to open and close valves much faster than can a conventional type operator. Further, it is so trouble-free that it can be operated for a year or more without the need of shutting down the line for repairs or adjustments to the control.



TYPE S.C.



TYPE O.S.

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LimiTorque Valve Controls

ple houses, fire-engine houses, garages, etc. Careful attention to fitting the asbestos sheeting will result in a reasonably fireproof structure. The use of asbestos shingles applied over fireproof weatherboard also results in a neat-appearing weatherproof structure requiring the minimum in maintenance.

Main unit foundations are ordinarily built up on a reinforced mat with the foundation tied to the mat with steel dowels. When steel is not readily available and where ground conditions permit, the ground itself may be used as a form, the hole being spread out somewhat at the bottom to provide a large bearing area. A form is then built for the exposed upper position of the foundation and for hanging the bolts and the entire foundation poured monolithic. For electric units or other relatively small unit foundations this type of construction results in a very stable base as the supporting dirt is not disturbed. A little more care is required in the excavation and in attention to the proportions of the concrete mixture. A 1-2-5 mix with not more than 7 gal. of total water gives good results when well worked to eliminate voids.

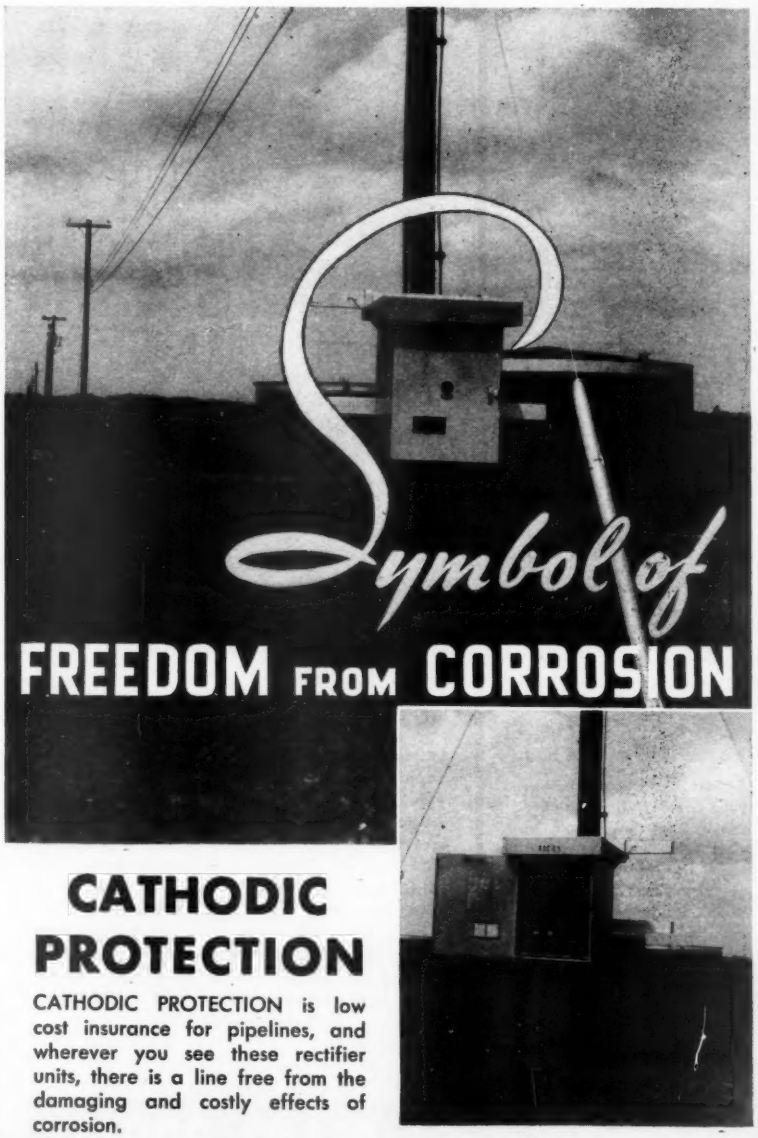
Building floors, especially where poured over excavations for pipe trenches, present a problem when reinforcing steel is not available. The backfill should be well tamped using a minimum of water, the entire area well tamped and allowed to dry out for several days before the floors are poured. The area should then be carefully marked off and poured in sections of not more than 400 sq. ft. being sure to use at least a ½-in. expansion-joint material around all foundations and against all walls. Pipe protruding through the floors should be wrapped with at least three layers of asphalt roofing paper for the depth of the slab.

Each slab should be a continuous monolithic pour and should be completely finished before the next slab is started. A mix in the proportions of 1-2½-5 should be satisfactory. The last ¾-in. should be a finish mixture of fines floated in place before the base sets up. Where coloring material is used this may be added to the floated finish and steel troweled in if reasonable care is used to distribute it evenly. Such a floor will, of course, show cracks or score marks at the joints, but the individual slabs should not crack if they are poured to a thickness of at least 6 in.

Heavy slabs such as may be used to support switch gears may be well reinforced if the wiring conduit can be arranged to act as reinforcing. Where this cannot be done and where the slab must be poured in fill, as is usually the case, post holes should be dug well into the solid ground. These holes should be at least 6 in. in diameter and it is usually possible to find some piece of old pipe, conduit or rod to reinforce them and tie them to the main slab. The holes and slab should, of course, be poured all at the same time and the slab should be separated from the surrounding floor with an expansion strip.

Large slabs which must be continuous, such as a servicing slab in front of a battery of "hay tanks," present a serious problem when adequate reinforcing is not available. The amount of reinforcing may be decreased materially if a base of coarse rock or gravel, with some provision for drainage, is provided. Such an arrangement is shown in Fig. 2. This arrangement will be found to work equally well for dry or excessive moist soil and is especially effective when freezing soil conditions are encountered. Cross-runs of ¾-in. steel on 2-ft. centers, wired together and supported on the rock fill should prove adequate. The curbs are formed up and the entire slab is made with a continuous pour using a concrete of 1-2½-4 mix with only enough water to make it workable.

Concrete sump tanks in lieu of steel sump tanks are not new, but for products sumps they have never



CATHODIC PROTECTION

CATHODIC PROTECTION is low cost insurance for pipelines, and wherever you see these rectifier units, there is a line free from the damaging and costly effects of corrosion.

BRANCE-KRACHY COMPANY, Inc.
HOUSTON, TEXAS

been too satisfactory. Three-compartment rectangular tanks, each compartment having a capacity of approximately 100 bbl., have been built to hold products successfully. They are built with 8-in. side walls using a minimum of steel, are leakproof from the outside as well as the inside, and the concrete is apparently holding up under the action of the products.

After the excavation is completed, the bottom is leveled off and well tamped, the outside forms are erected and well braced to the sides of the hole. A light steel mat is then laid on the bottom and blocked up. The compartment forms consist of a well-braced bottomless box, the top sheeted over and braced and the necessary manway openings formed up. These forms are then lowered into position and the steel reinforcing mats for the side walls and compartment walls are accurately positioned and wired together. If the rods forming these mats are tack-welded together instead of being wired they are much more rigid and far easier to handle and place accurately.

After the reinforcing is placed, the compartment forms are positioned accurately and rigidly from crossmembers tied to the outside wall forms. No wire ties are used between the outside forms and the compartments but removal blocks may be used to help hold the compartment forms in place and until the concrete can provide the necessary support.

Threaded nipples of the desired size with a 1-in. wide plate steel collar or shield or a heavy rough welding bead midway of their length are fitted through the forms at the desired point for pipe connections. The nipple should be clean and provide the best possible bond with the concrete.

To be successful the concrete pour must be continuous and of the right mix and consistency, and the forms must be well vibrated at all times. The bottom is, of course, poured first and a man in each compartment keeps the concrete well tamped and with a reasonably smooth finish. By the time the bottom is poured (preferably with quick-set cement) it is sufficiently well set up to start pouring the side walls. The concrete should be deposited evenly and progressively around the periphery of the forms and it will be found self-supporting. Continuous use of a mechanical vibrator is essential at least for the larger sumps. Where it is found impractical to complete the pouring of the top with the side walls it is well to imbed a continuous strip of 6-in. wide corrugated sheet iron in the top of the wall with about 3-in. showing for a seal when the top is poured.

Removal of Forms

The forms should be removed as soon as possible after the concrete has set up and the entire inside rubbed down thoroughly using a neat mixture of very fine sand and cement with the block. This results in a very smooth dense surface apparently impervious to the action of oil or products and of course seals such voids or porous spots as may exist.

The outside surface may be treated in the same manner, may be painted with one of several commercial waterproofing compounds or may be left to dry thoroughly and be heavily coated with a tar compound or pipe-line doping materials. Connecting piping must be well supported to prevent excessive strain when the backfill settles.

Various experiments have indicated that a 1-2-¼-3 concrete mix using a good grade of cement, washed river sand and ¾-in. maximum gravel with a maximum of 6 gal. of water (including the water content of the sand and gravel) results in a very dense concrete which if properly vibrated, is virtually free of voids and has a very high degree of resistance to breakdown from the action of oil products.

Other pits such as drains, scraper trap pits, etc., which would be ex-

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Leading operators and pipe line contractors are rapidly discovering that the quickest, cheapest way to backfill pipelines is with dozer-equipped tractors. On actual job runs, these sturdy, efficient machines are backfilling up to *three times more trench per day* than old fashioned methods—at a substantial saving in cost and manpower. Next time, do it with a dozer and you'll get more work done faster, with fewer men. For helpful operating ideas, for reliable parts and service, see your nearby LaPlant-Choate "Caterpillar" distributor. LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa.

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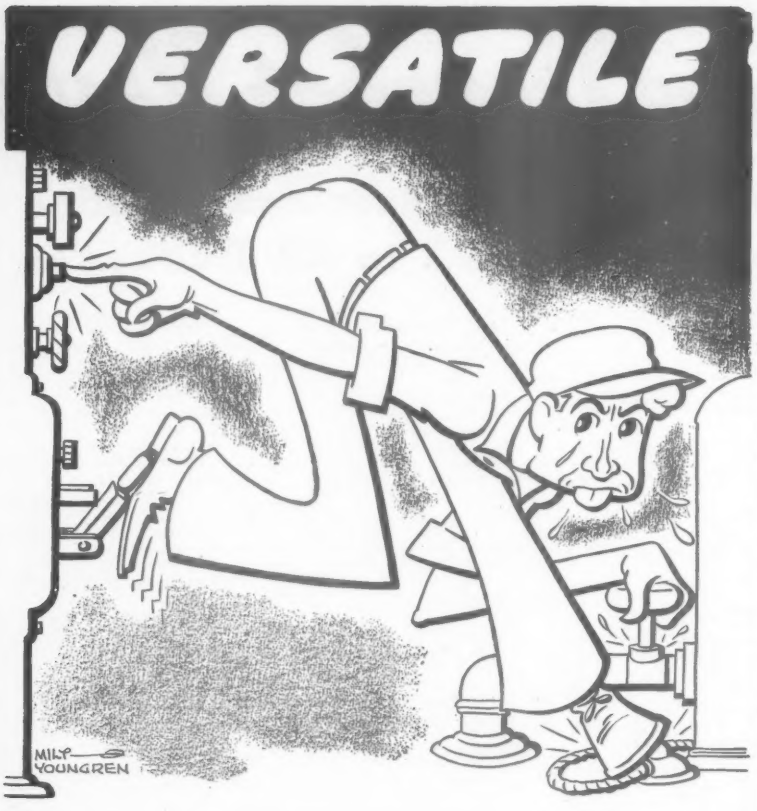

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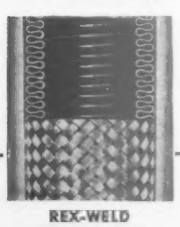

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Flexible Metal Hose for Every Industrial Use

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Plants: Maywood and Elgin, Ill.

posed to the action of such liquids should be treated in much the same manner. It has been found that such open top pits can be successfully poured without reinforcing steel if the concrete is well tamped and if a 3-in. fillet is formed in each corner.

Steel has not been available for electric substation construction and the use of other materials is difficult because of the weights of electrical apparatus and the need of rigidity to maintain it in alignment. A thorough study of the various problems involved has shown that construction of such a station can be accomplished by using heavy creosoted line poles set in concrete and tied and braced with bolted creosoted timbers. By attention to the arrangement of the fuses, arrestors, switches, cutouts, etc., to distribute the loading, and by proper bracing a satisfactory design can be worked out. The substructure should be erected in the field and clamped together in position before bolting. A typical installation is shown in Fig. 3. A wooden picket fence with creosoted posts will prove as neat appearing and as effective a guard as a cyclone type steel fence for station transformer yards. Removal sections provide access for working trucks.

New Approach Necessitated

Limitations placed upon the construction of employes houses by the governmental authorities necessitates an entirely new approach to this problem as the limitations placed upon materials and especially floor space are quite restrictive. These must be worked out for each individual requirement and even the construction of a considerable number of similar units does not give the economic advantages of the old type prefabricated semiportable houses. The use of asbestos shingles on weatherboard with plaster board for the inside walls results in a more weathertight and livable abode. Various makes of scored tile board and asphalt floor tile are available for bath rooms and kitchens and with the exercise of a little ingenuity the architect can design a very livable dwelling, well within the limitations imposed. There will not be much salvage value to the buildings, however, and this feature must be given consideration.

In general the wartime restrictions in certain building materials do not impose too great a hardship in new pipe-line construction, but do require the exercise of ingenuity and forethought which has already resulted in the discovery of new methods and savings in costs not previously considered. No doubt many of these features and savings can be carried on into postwar projects at considerable advantage.

Atmospheric Temperatures on Portland Line Vary 152° F.

by J. L. Creed *

THE Portland - Montreal pipe-line system was constructed during the warmer months of 1941. Initial engineering work was started in May and first oil pumped into the line November 5, 1941.

Details of System

The line starts at an elevation of approximately 20 ft. above sea level at South Portland, Me., and continues north and west for a distance of 236 miles, traversing the granite ledges of Maine and three mountain ranges, the White Mountains of New Hampshire, the Green Mountains in Vermont, and the Sutton Mountains in Quebec, crossing the Richelieu and St. Lawrence rivers and ending at Montreal East at approximately same level as the starting point. The highest elevation on the line is 1,960 ft. at a point just west of the Lancaster pump station in New Hampshire. The line is 12 in. and is all-welded construction designed for working pressure of 800 lb.

The eight pump stations are located 25 to 40 miles apart for balanced pumping and pressures. The buildings are of brick, concrete, and steel construction designed for permanency and warmth.

The three stations in Maine and two stations in New Hampshire are each equipped with two 27-in. stroke, 30,000 - bbl.-per-day-capacity, triplex, double - acting plunger pumps powered with 500-hp., 2,300-volt, synchronous motors, designed for a speed of 327 r.p.m. The station located in Vermont at an elevation of approximately 1,128 ft. has two of same type pumps powered by two direct-connected 16¼-in. by 23-in. four-cycle, six-cylinder, heavy-duty, straight diesel engines. One of the stations in Canada is electric drive with the same equipment as those in Maine and New Hampshire, and the other has two of same type of pumps of 24-in. stroke, powered by two 500-hp., five-cylinder straight diesels.

A terminal and unloading dock is maintained in Portland harbor capable of berthing at one time, two of the largest of tankers and unloading each at rate of 15,000 bbl. per hour. A delivery terminal is located at Montreal East, Quebec, with tankage for temporary or emergency storage.

Originally, six 140,000 bbl. steel tanks were erected at South Portland. These tanks are standard A.P.I. all-welded structures, 144 ft. in diameter by 48 ft. high and are equipped with floating roofs. Two additional tanks of 135,000-bbl. capacity of similar design are now being constructed at this location.

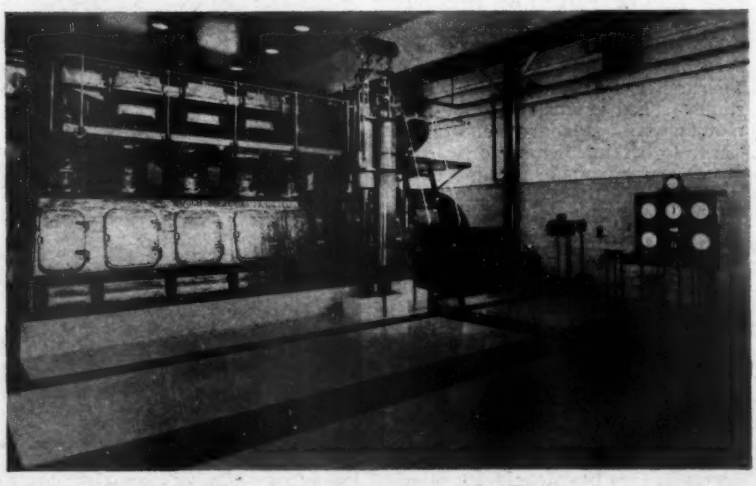
The intermediate stations are each provided with a 30,000-bbl. steel tank standard A.P.I., all-welded structure, 70 ft. in diameter by 48 ft. high. These station tanks float on the line except when system is completely closed to avoid contamination.

Cottages are provided for intermediate station personnel, as at times, due to heavy snow, travel is most difficult and it is a distinct advantage for continuous operation under these conditions to have the station crews near the plant.

The system was constructed as a war project and has been of incalculable value in delivering oil to Eastern Canada during the war period, as by the use of this means of transportation the distance traveled by tankers loaded with oil for delivery to Montreal refineries has been decreased by 2,300 miles, resulting in a considerable saving in tanker time. In addition, pipe-line deliveries have been maintained the year around, whereas previously tanker deliveries at Montreal were limited to 7 months due to the St. Lawrence River freezing over and being closed to traffic from about the end of November to the end of April.

During the warmer months from May through October, the line pre-

Main-line station: manifold house and pump house in a winter setting



Interior view of engine room of diesel station

*General Superintendent Portland Pipe Line Co.

sents no difficulties that are not encountered by those operating pipe lines in other sections. An automobile trip over the line during this period, visiting the stations, is a beautiful vacation holiday; but in winter with 4 to 6 ft. of snow along the right-of-way and tree-top deep in the mountain ravines, a trip over the line becomes a hardy adventure, with many a slip and slide following the path of the snow plow or digging out of drifts. A shovel, tire chains, rope, extra jack, axe, extra clothing, blanket and great coat are standard equipment for a maintenance man, and he is wise who constantly provides himself with emergency food including a few chocolate bars, plenty of matches in a weather-proof box and cans of heat. If the motor falters, one is liable to be confronted with a several-mile walk facing a 40 or 50-mile blow at 20° to 50° below zero. Those who have not faced this kind of weather can hardly appreciate its frozen intensity. It is a bitter, biting, cruel enemy that is merciless to those that do not cope with it properly.

In this kind of weather, the station heating plant becomes possibly the most important and necessary piece of equipment the pumping station contains, because if it fails, the lubricating system begins to give a great deal of trouble and men cannot long continue to operate the plant.

Design for Cold Weather

Those responsible for the design and construction of the Portland-Montreal system were well aware of the importance of proper protection against the severe winter conditions, and proper provision was made to the end that little difficulty has been experienced.

Fuel for heating is taken either from the passing stream, through a meter, or from the 30,000-bbl. station tank. A completely enclosed-type heating system is employed, having a capacity of approximately 5,000 sq. ft., with operating pressure of 15 lb. and tested to 100 lb. Thermolier heaters equipped with single-speed explosion-proof-type motors are standard equipment. Careful arrangements for proper drainage were made at time of installation and little difficulty in operation has been experienced.

The main line was laid several feet below ground with a great deal of slack and well covered, which experience has since proved to be a wise precaution. Atmospheric temperature of —50° F. was registered at the West Burke, Vt., station during the last two winters and the lowest line temperature recorded since the beginning of operation has been 32° F. In spite of this, not one leak in the main line has developed, which is remarkable when the atmospheric

Typical group of company cottages constructed at main-line stations for employes

temperature range is considered; 96° above to 56° below, and 30° to 40° drops in temperature in the low cold range are not unusual. Then too, when the spring thaws start, avalanches of water, slush, snow, and ice come rushing down the mountain gorges where the pipe is buried.

As winter approaches and temperature drops are expected, a great deal of care must be exercised in accepting tenders of crude for transportation through the system; as sometimes crude is tendered that, due to high pour test, cannot be handled safely during low-temperature weather. Before tenders are accepted for delivery during this period, a very careful check is made of the crude characteristics in order to determine viscosity, pour, gravity and wax content. As a matter of practice, with a line temperature expectancy of 32° during severest weather, crudes with a pour of above 20° have not been handled during the winter. One crude of 47.1° A.P.I. gravity handled during the warm months at capacity, congeals at 34° and cannot be pumped during periods of low line temperatures.

Interior view of motor room, electric main-line station

Crude characteristics are studied in advance of cargo loadings for Portland and where pour points approach the danger area, careful checks are made by the company prior to accepting the cargo. At present, a well-equipped laboratory is being constructed at the South Portland station where viscosities and distillations will be made of all crudes handled in order to determine pertinent characteristics.

It is necessary to keep the line as constantly in operation as possible during low temperature periods, as experience has shown that when the line is shut down for several days, lower crude temperatures result than prevail if the oil is kept in motion constantly.

Temperature recorders are installed on the instrument panels at each station for both line and atmospheric readings. These readings are reported to the Portland dispatcher's office daily at the beginning of each 8-hour shift and the charts are subsequently mailed to Portland office. The ground temperature is taken at Gorham, N. H., station and at West Burke, Vt., station as of 7 a.m. each day and reported to dispatchers.

Temperature is a most important factor in the operation of the system, as during the winter months pumping capacity on low-gravity, high-viscosity crudes is greatly reduced.

One of the main problems is handling lube-oil crude through the system with minimum contamination with other crudes, particularly of a paraffin base. The rapid temperature drop of waxy crudes during the time they are in transit through the line particularly during the winter, causes a natural process of dewaxing. A great deal of effort and thought has been devoted to the problem of contamination and it has been through the cooperation of the concerted efforts of all concerned that a system has been developed which has given satisfactory results.

As far as the present exigency

AT THE BATTLEFRONT!

Republic Electric Weld Pipe

PORTABLE pipelines have proved to be the best way to keep vital fuel supplies right on the heels of fast-moving Allied attack forces. They were an important factor in the dash of American forces across North Africa—and in the over-running of Sicily. Now, they're a front line weapon in many war theaters. And a lot of them are built of Republic Electric Weld Pipe.

These warfront pipelines are specially fitted for fast assembly—10 to 20 miles can be laid in a day. They are lightweight—a 20-foot length of 4-inch pipe weighs only 90 pounds. They can move from 6,000 to 12,000 barrels daily over all types of terrain. They are hard to see, harder to hit, from the air. Their flexible joints increase their shock-resistance. Damage can easily be spotted and repairs quickly made. The saving in lives, trucks, gasoline, oil and time is considerable.

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Back here on the home front, some 50,000,000 feet of Republic Electric Weld Casing and Tubing are tapping underground reservoirs of fighting fuel. More than 30,000 miles of Republic Electric Weld Line Pipe are carrying millions of barrels of war fuel on their way to the battle areas. And over 120,000,000 feet of Republic Electrunite Boiler and Heat Exchanger Tubes are helping in refining and other important industries.

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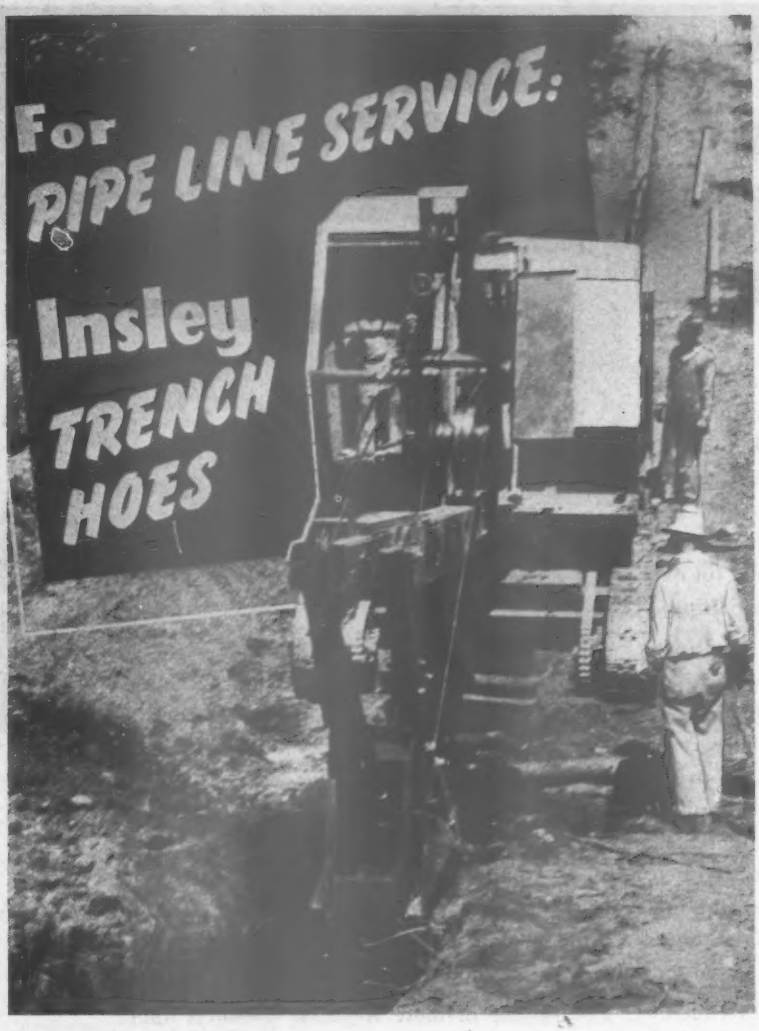

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will permit, cargoes of lube-oil crude are accumulated in South Portland tankage for batching in as great a quantity as possible. Tanks which are to receive this type of crude are pulled down as low as possible or tests made of bottoms to determine their propensity to contaminate lube-oil crudes. Extreme care is taken in making line displacements and an excess displacement above line capacity is the usual practice. Samples are taken from each boat as well as from shore tankage before and after discharge. These samples are checked for cold test and cloud in order to be sure that no contamination has taken place in shore tankage. Scrapers are run some 10,000 bbl. ahead of each lube-oil-crude batch and the station surge tanks are shut off completely and the line operated as a completely closed system. The station men are all advised in advance of the movement and care is exercised that no possibility of mixing crudes may ensue. On arrival at Montreal, about 10,000 bbl. of the head of the stream are sloughed off. As a result of precautions which are being taken, the condition of lube-oil crude delivered at Montreal has on the whole been quite satisfactory.

Maintenance

Maintenance of the system is largely a seasonal matter, as after the snow flies and the ground freezes, some winters to a depth of 4 or 5 ft. at the coldest locations, the difficulties of doing work on the outside are prohibitive except in the most extreme emergency.

The line and right-of-way are inspected each summer, and where the line is uncovered or where washouts have occurred, repairs are made and the line made ready for another winter.

After the spring thaws are over, repairs to drainage systems, walkways, mats, pole lines, and cottages that have been disrupted by "frost heave," snow and ice, are made. Grass on station and cottage lawns that has been winter killed is reseeded. Heating systems are cleaned, tested and inspected and repairs made where necessary. It is more or less a proposition of each summer repairing the ravages of the proceeding winter and working to get ready to successfully go through another winter of operation.

When it is necessary to make repairs to buried lines during low-temperature periods, the lines have to be uncovered by the use of air compressors and concrete busters or "ice busters." For the past three winters, the St. Cesaire, Canada, station has only been accessible from the main highway, a distance of approximately 2½ miles by a horse-drawn sleigh.

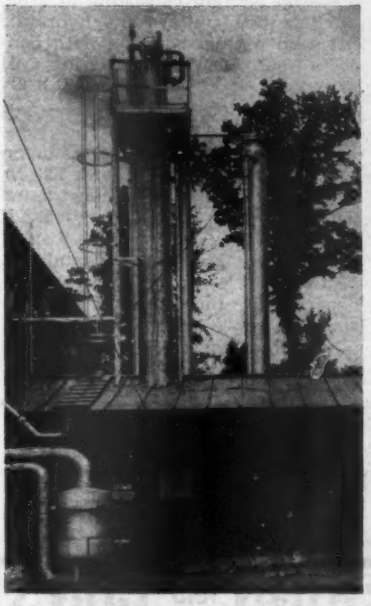
Iron Oxide Versus Liquid Treating For Purifinyg Natural Gas

*by Charles F. Turner**

WHEN sour natural gas is encountered during the development of a gas field it is usually necessary to remove the hydrogen sulfide before the gas is acceptable for distribution to gas-company consumers. A question naturally arises as to the choice of methods to use for its removal. If the volume of gas to be treated is large or the concentration of hydrogen sulfide is high there is no alternative; the only practical method is some form of liquid purification process in which the gas is scrubbed free of hydrogen sulfide by bringing it into intimate contact with a liquid which will combine with the hydrogen sulfide. Such a system is continuous and easily adjusted to varying rates of flow and degrees of sourness. If, on the other hand, the volume of sour gas is small or the hydrogen sulfide concentration is low, the iron-oxide sponge method, which has been used in the manufactured-gas business for years, may have certain advantages over the wet method and should not be ignored when occasion arises to consider possible purification processes.

The East Ohio Gas Co. has had considerable experience with the iron-oxide method, having used it for several years in two different fields. For the past 2 years it has been operating a plant in which gas from the Newburgh sand containing 10 grains per 100 cu. ft. of hydrogen sulfide is purified by the oxide method and gas from the Oriskany sand containing 220 grains per 100 cu. ft. of hydrogen sulfide is purified by a liquid process, the two being carried on simultaneously. A summary of the company's experience with the two methods may be of interest to others who find it necessary to convert sour gas into sweet gas.

*Chief chemist, The East Ohio Gas Co.

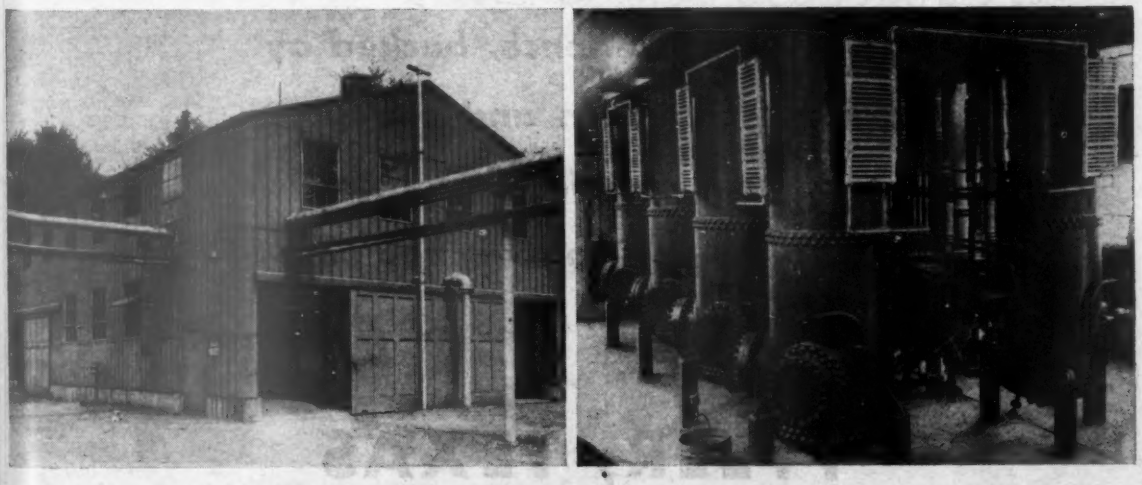


View showing Girbotol unit with 21-ft. by 28-ft. building over lower elements of unit

It may be said at the outset that the so-called dry (oxide) method is competitive with the liquid method (Girbotol, sodium carbonate, phosphate, etc.) only when the total hydrogen sulfide content to be removed in 1 day, measured in grains per 100 cu. ft., is not so high as to require an excessive investment and to become burdensome and costly in operation. Labor costs, purifying pressures available, necessity for continuous throughput, availability of steam, water, electric power, proximity to dwellings or community centers and other factors will largely dictate when the oxide method should seriously be considered.

Purifying Materials

There are available on the market today many prepared purifying materials containing iron in the form of oxide, Fe_2O_3, or hydroxide, $Fe_2(OH)_3$, as the active purifying agent. Some of these are obtainable ready for use while others are designed for mixture with wood shavings. Those ready for use are either



Left: View of 38-ft. by 57-ft. building housing eight oxide boxes. A pile of oxide is visible near door. Right: view of oxide "boxes" showing arrangement, cleanout openings, interpiping, oxide bucket, top platform and radiators

ready mixed with soft wood shavings, hardwood chips, or in some cases with pumice stone or slag. The latter two have the advantage of being more fireproof than those using wood. The sole purpose of the shavings, chips, pumice or slag is to provide a leavening agent to permit easy flow through the mass without channeling and excessive back pressure; they do not in any way enter into chemical combination with the hydrogen sulfide. The oxide used by The East Ohio Gas Co. has always been of the type which is mixed with shavings, the shavings being preferably of soft pine which curl well and to which the oxide clings when moist. It is usually purchased on the basis of its Fe_2O_3 content which is specified to contain in the neighborhood of 35 to 38 per cent of active Fe_2O_3.

In preparing the oxide for use, the shavings, which average around 8 or 9 bu. to the bale, are spread out in a layer about 10 to 12 in. deep. The oxide is distributed over the bed in the proportion of 25 lb. to a bushel of shavings and the two thoroughly mixed dry using scoops or tined forks similar to those used in handling coal. The mix is then sprinkled with water until it is thoroughly wetted through but with no excess water running out of it.

The apparatus in which the sponge is placed and through which the gas passes was built in 1929 for use in a sour-gas field where the gas averaged 15 grains hydrogen sulfide per 100 cu. ft. and was purified at an operating pressure of 200 p.s.i.g. It was later moved to its present location where it has been in continuous use since 1939. The essential units of which it is comprised are: Eight cylindrical "tanks" with bulged heads mounted vertically in two rows of four each; two 8-in. parallel headers running between the two rows (which are on about 10-ft. centers) and lying in a horizontal plane, 6 ft. from the floor; 6-in. interconnecting piping with plug-type, lever-operated valves; a steel rail-enclosed loading platform level with the tops of the tanks; an oxide elevating system consisting of 2-bu. bucket, rope, pulleys and hydraulic lift; and a steel building with concrete floor enclosing the entire unit assembly.

Tank Arrangement

Each tank is 48 in. in diameter, 15 ft. in length and built for 350 lb. working pressure. It is constructed with lap joints, riveted, though if built today it would be welded throughout. Each head contains a 11 by 15-in. oval boiler-type manhead. Near the bottom, and 90° apart, are two 14-in. nozzles fitted with blind covers bolted on and supported on swinging davits. Fouled oxide is raked out of these openings onto the floor when the contents are being replaced. A wooden tray made of ½ by 2-in. slats on 1-in. centers is located on a level with the bottom of the nozzle openings. Condensate collecting in the bottom below the tray may be drawn off through a 1-in. drain.

One of the 8-in. headers brings sour gas to the unit and the other takes the sweet gas away. Each is provided with spur-gear-operated plug and safety valve. The 3-in. piping between boxes is so arranged that four boxes in a square form a series, the gas entering each box below the tray, passing up through the oxide and out through a side outlet near the top. In this manner the gas passes successively from bottom to top of each box, or if desired, from top to bottom, though the downward direction tends to cause packing of the oxide and is not recommended. The two series of boxes are connected in parallel so that one-half of the entering gas passes through each series. Bypasses are provided for each box so that it may be cut out of the series for oxide change.

Each box is filled to a depth of about 10 ft. above the tray. At this depth the capacity of each box is about 90 bu. Gas is passed through all four boxes in the series until the gas leaving the second box

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shows a noticeable stain on lead acetate paper. The first or front-end box is then cut out for oxide change and the second box becomes the front-end box. When fresh oxide has been placed in the box cut out it is placed last in the series. In this manner the position of each box in the series is rotated and the freshest box is always last in the series. This arrangement insures sweet gas leaving the plant at all times.

When a box is opened preparatory to dumping, a water hose is ready at hand and the fouled mass well wetted down from time to time as it is raked out on the floor. The reaction between iron sulfide and air takes place rapidly at first with the evolution of enough heat to raise the temperature to the kindling temperature of the shavings if they are not kept wet. Armed with knowledge of this fact and with a garden hose there is no excuse for having a fire at any time. The mass is turned over once a day and is usually ready for reuse on the third day.

The number of foulings or revivifications for a given batch of material depends upon several factors, but an average figure is about 10 to 12 times. Optimum conditions for purification are realized when the oxide is maintained well on the alkaline side (a pH around 10.5 to 11) and at a temperature not lower than 50° F. The alkalinity is easily maintained by mixing in a pound or so per bushel of flake caustic two or three times during its life. Experience has shown that when mixed and used in the manner described the average amount of hydrogen sulfide which 1 bu. of sponge will remove over its useful life is about 12,000 grains per fouling. Using this experience factor as the basis for estimating, the size of the purifying plant and the operating costs can be calculated for other situations. The plant has purified very satisfactorily as much as 15,000,000 cu. ft. per 24 hours (calculated at low pressure) of 10-grain gas at an operating pressure of 325 p.s.i.g. Under these conditions the velocity through the oxide bed has been calculated to be on the order of 8 lineal feet per second, a much higher velocity than has been considered feasible in manufactured-gas practice. The fact that the gas travels through 30 ft. of oxide (3 boxes by 10 ft. depth per box) making the contact time 3.75 seconds is probably the prime reason why this high rate is attainable. The number of bushels fouled per day under these conditions may be calculated as follows:

$$\frac{15{,}000{,}000 \times 10}{12{,}000 \times 100} = 125 \text{ bu. per day}$$

Since two boxes (one in each series) hold 180 bu., it means about 21 box changes per 30-day month

$$\frac{180}{125} \times 30 = 21.$$

Using the hydraulic oxide hoist, two men can empty and refill two boxes in an 8-hour day. A schedule was worked out which keeps two men employed continuously changing boxes and turning oxide. Two extra batches are kept ready for loading so no delay is incurred.

As the output of the field drops off the number of bushels of oxide fouled in 1 day will likewise decrease and the change program can be revised from time to time so that boxes may be changed every other day, then every third day, etc.

About 2 years ago gas began to be produced from the Oriskany sand in the same general area. The volume produced was about the same as that of the Newburgh but it contained 11 times as much hydrogen sulfide. It was obvious that this gas could not be handled by the oxide method and so a liquid-treating unit was purchased and installed to purify the 220-grain gas. Piping is so arranged that gas leaving the unit may be merged with the gas entering the oxide boxes, or it may be bypassed into the plant discharge. Newburgh gas may likewise be merged with the Oriskany and

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Power that keeps

A typical installation of motors and ventilating air ducts of a WEP 24" crude oil line station.

A transformer bank and transmission line to a main line major company pumping station in Oklahoma.

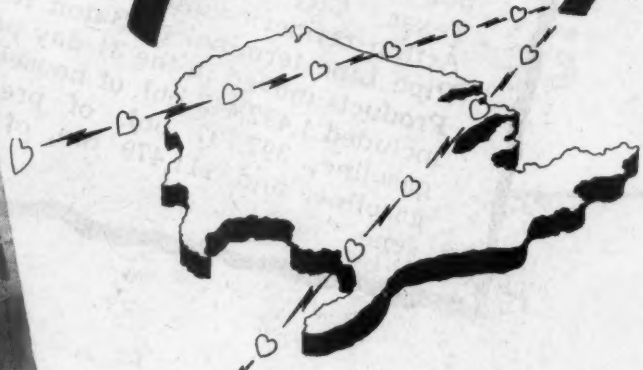
A typical example of how Utility Electric Power is being utilized for efficient and economical operation of pipe line stations throughout America.

Exterior view of a WEP 24" crude oil pump station.

the nation's pipelines *Pulsing*

The control desk with a view of the pump room through the glass partition in a WEP 20" products line station.

Pipe line stations like one above are delivering thousands upon thousands of barrels of oil and gasoline daily to vital points of distribution at rock-bottom costs.



FACTS WORTH REMEMBERING . . .

Three years ago American tankers, filled with precious petroleum products, were being destroyed, damaged, and burned at an alarming rate.

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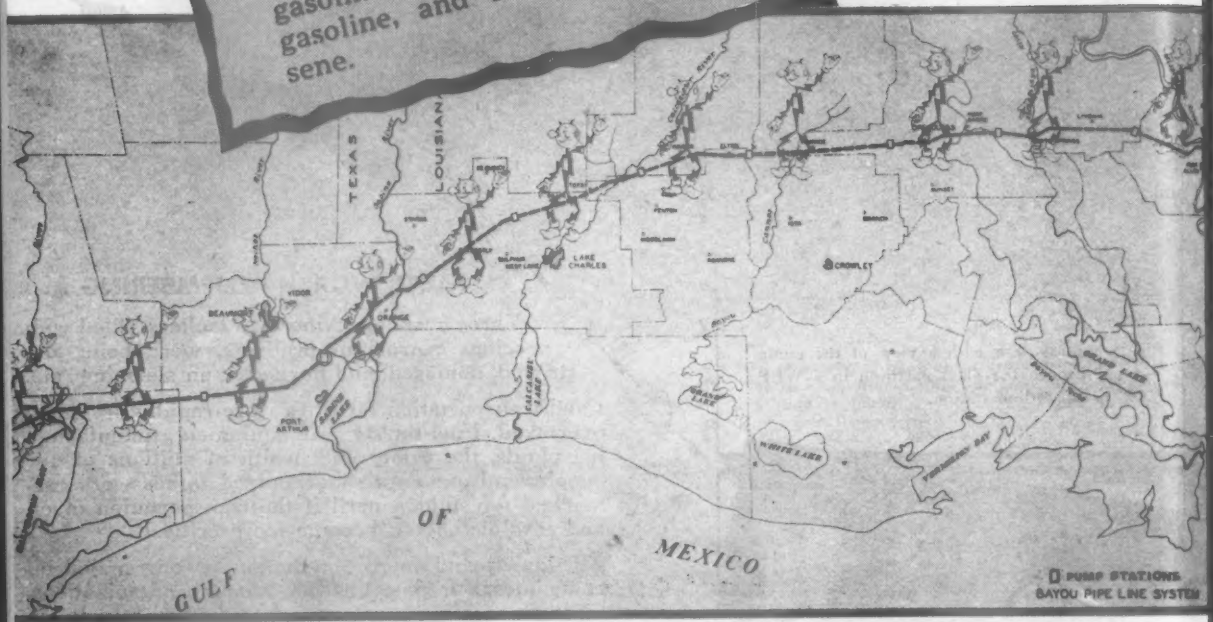
Bayou Breaks Record With High Throughput

Bayou Pipe Line System set a new delivery record for July by pumping a daily average of 64,569 bbl. of products from the Houston-Texas City and Beaumont-Port Arthur refineries into the Plantation Pipe Line terminal at Baton Rouge. Products moved in the 31-day period included 1,492,443 bbl. of housebrand gasoline, 397,737 bbl. of premium gasoline, and 111,479 bbl. of kerosene.



Gulf States Powers the Push . . .

The record of the Bayou Pipeline system is outstanding from the very beginning when Crown Central, Humble, Pan-American, Pure, Shell, and Texas pooled their resources to make the system a reality. Built in record time despite many difficulties the system continues the pace that has won the admiration and respect of oil men everywhere.

The Bayou Pipeline utilizes electric power throughout for its pumping requirements. Nine of its eleven pumping stations are served directly by Gulf States Utilities. Another is served indirectly.

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passed through the liquid treater, and at times this is done.

In the liquid unit gas is scrubbed with 5 to 10 per cent of an organic liquid and water in a contactor tower filled with 2-in. Raschig rings and built for 350 lb. working pressure. The gas leaves the tower as free from hydrogen sulfide as it does from the oxide. The rich solution is stripped of hydrogen sulfide in a steam heated plate-and-bubble-cap tower, cooled and recirculated by a steam-driven plunger-type pump capable of pumping against the pressure in the contactor. The pure hydrogen sulfide gas which leaves the reactivation tower is piped to the boiler house some 40 ft. away where it is burned.

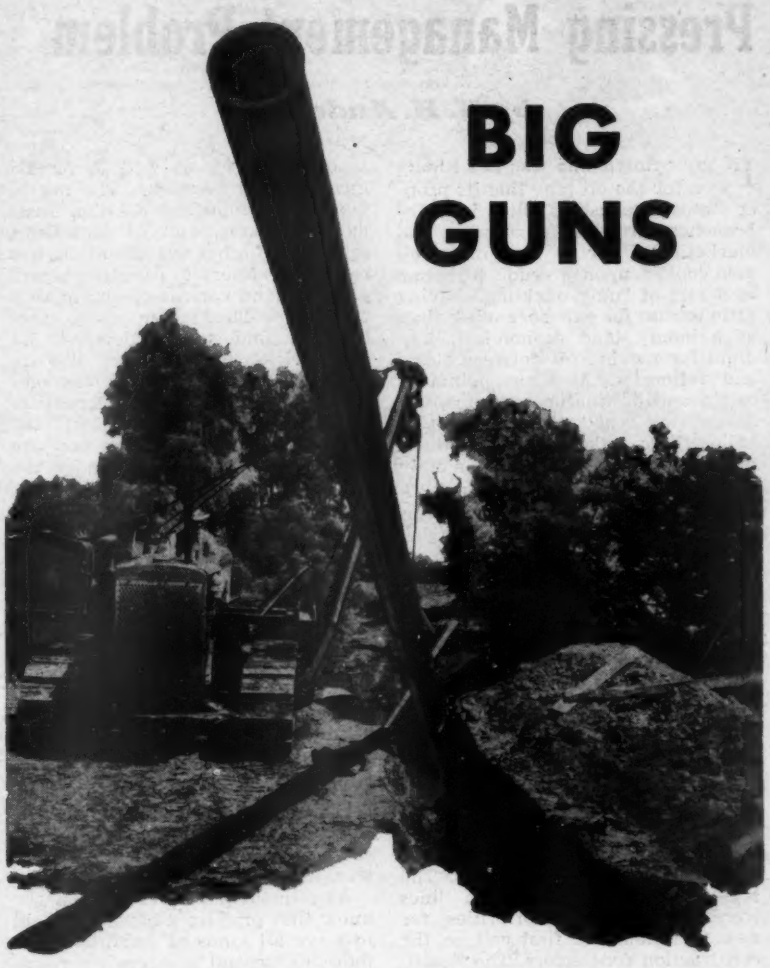
Advantages of Oxide

The chief advantages of the oxide method over the liquid process are: (1) It requires no steam (if housed in a building it is rarely necessary to provide heat in the radiators provided); (2) it produces no highly toxic, highly concentrated hydrogen sulfide gas; (3) it can be used in small isolated sour fields where inexpensive units can be assembled out of lengths of standard pipe much in the manner as the larger units described here.

The disadvantages of the oxide method are: (1) The lack of flexibility in accommodating variations in flow rate or hydrogen sulfide content; (2) its impracticability where the sulfur load to be removed is high; (3) the production of an evil-smelling spent oxide which must be disposed of quickly and effectively when the plant is in proximity to inhabited areas.

The advantages of the liquid process are: (1) Its flexibility so far as accommodation of variations in hydrogen sulfide content is concerned; (2) greater freedom from odors attendant on its operation. The chief disadvantages are: (1) the necessity of keeping an attendant on duty all the time when it is in operation; (2) the production of a highly toxic gas which must be disposed of safely either by burning or by reducing to free sulfur; (3) the danger of passing sour gas if for any reason the circulating system ceases to function. To avoid this possibility is one of the chief reasons for keeping an attendant on duty at all times. In some plants steam generation for reactivation has been obviated by the use of "Dowtherm," a high-boiling organic liquid, which is heated in an automatically controlled gas-fired boiler and circulated through the reactivator tower. This makes it possible to make the plant entirely automatic but where it is imperative that sweet gas leave the plant at all times the safest procedure is to keep an attendant on duty at all times.

Look Ahead With First National



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Operation of Partial Loops

This article describes a year's experience with 152 miles of partial loops, 4 to 22 miles long

*by F. B. Neptune**

THE first partial loop on the Phillips Products Pipe Line System was placed in operation April 30, 1942, and the most recent one April 2, 1943. We, therefore, have had in excess of a year's experience with approximately 152 miles of partial loops varying in length from 4 to 22 miles. Fig. 1 is a map of the system showing the location of these loops to scale. We have approximately 11 miles of loop in Texas, 19 miles in Kansas, and 122 miles in Missouri. Fig. 2 shows the piping and control arrangement of the partial loops. Originally the loops were installed with automatic equipment consisting of diaphragm-operated motor valves actuated by differential pressure from flow nozzles in each branch. However, during periods when the automatic controls were inoperative for adjustment or repair, our operators found that equal flow could be maintained very easily through the loop branches by manual control. We have since discarded the automatic controls and have experienced no difficulty in controlling the flow manually. Pressure from each branch of the loop is carried to a recording manometer which has a maximum range of only 10-in. of water. Thus it can be seen that the differential pressure must be kept very low to remain within the range of the recorder. A typical chart from the recording manometer is shown in Fig. 3. The partial loops originate in the pumping station yard and the recording manometer is set so it can be easily seen and read by the operator in the pump room.

When the partial loops were first

*Assistanat manager, products pipe-line department, Phillips Petroleum Co.

The author of this article joined the oil industry immediately after graduating from high school at Bartlesville, Okla., his first job being with the production and engineering departments of Indian Territory Illuminating Oil Co. After being out of high school for 4 years, he entered University of Oklahoma in 1926, graduating in 1931 with a bachelor of science degree in oil-field management. He joined Phillips Petroleum Co. and for 4 years was in the research department, when he was made chief chemist at the East St. Louis pipe-line terminal. In the summer of 1939 he was assigned to starting of operations of the new products line between East St. Louis and East Chicago. In the fall of the same year he was made superintendent of the East Chicago pipe-line terminal. He served during 1943 on the Petroleum Industries Committee as products pipe-line coordinator for District 2. A year ago he was made assistant manager of Phillips' products pipe-line department.

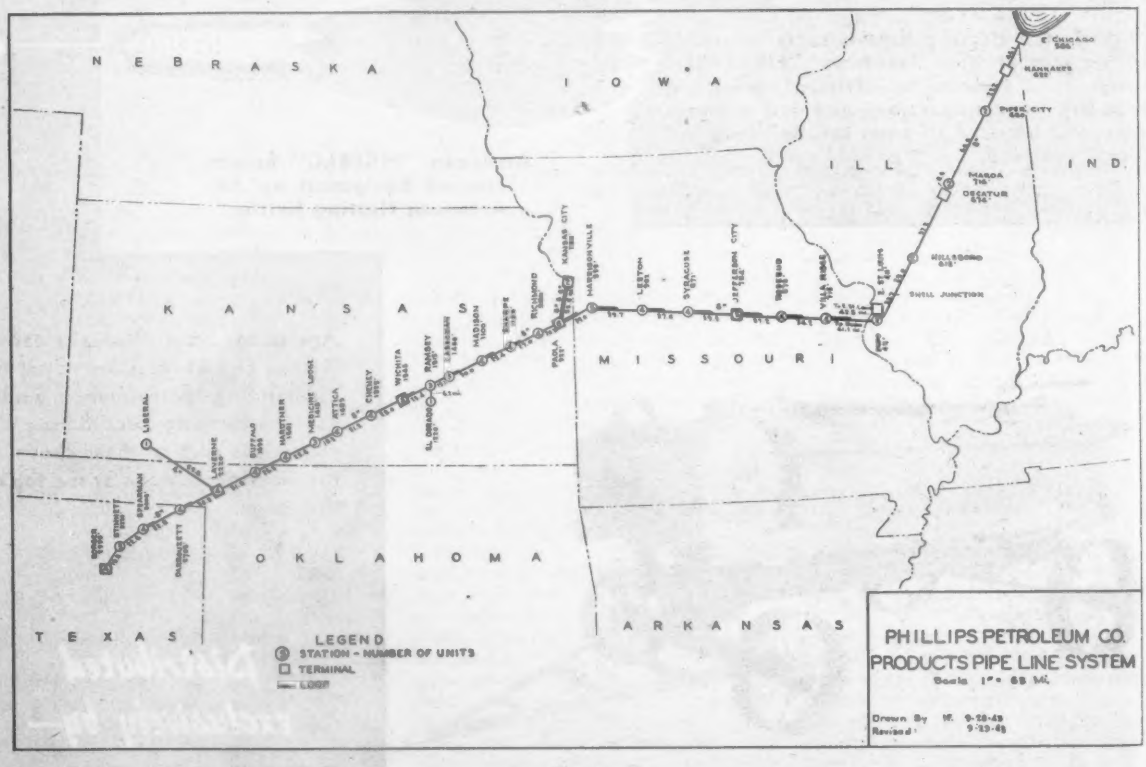

Fig. 1

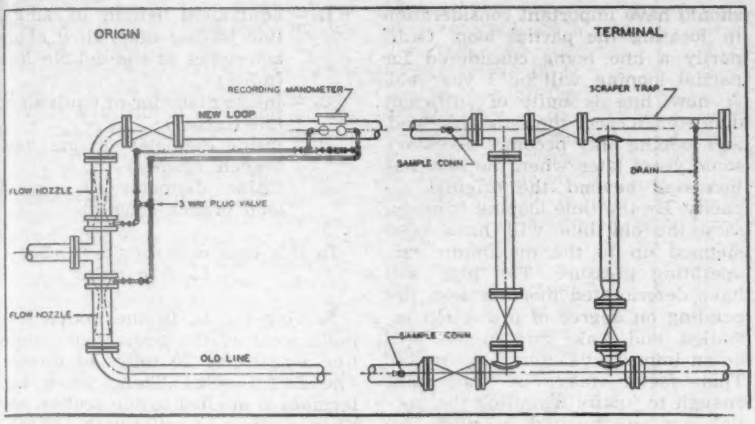

Fig. 2.—Typical partial-loop tie-ins

placed in operation it was thought necessary in order to avoid contamination to close the loops when passing special products. During the summer of 1943 we conducted an experiment which indicated that in normal operation we were experiencing only negligible contamination through the partial loops. A slug of high-vapor-pressure natural gasoline was put into the line at our Paola station immediately behind a slug of refinery gasoline. The pumping rate was maintained at 1,200 bbl. per hour and by taking continuous samples and checking the gravity at the tail end of the 13-mile loop it was found that the change of product lagged only 50 seconds in the old line. At the pumping rate of 10 bbl. per minute in each line, the 50-second lag meant that there was a total of only 16⅔ bbl. of mixed product or that 8⅓ bbl. of the high-vapor-pressure natural was passing the junction point and mixing with an equal amount of refinery gasoline. For the past year all products, including butane and high-octane aviation fuel but excepting kerosene and distillates, have been pumped with the partial loops open. If and when our line handles appreciable quantities of kerosene and distillates, we expect to pump this material also through the loops.

Locating Partial Loops

From a purely hydraulic angle, if all portions of a section to be partially looped have the same "C" factor, it makes no difference whether the section is looped on the high-pressure or low-pressure end of the section—or at some point intermediate. Our experience has been that the interior condition of the line as reflected by the "C" factor is not uniform even within a minor (station to station) section. "C" factors ordinarily are calculated from one pumping station to the next. Installation of partial loops on our system has afforded us an opportunity to take pressure-drop readings at intermediate points and determine "C" factors within minor sections. However, when connections are available for taking pressure readings, such determinations can be made on any line at any time.

In determining location of partial loops, several factors should be considered. These are:

1. The "C" factor gradient in the section to be partially looped.
2. The age and condition of the line.
3. Convenience of operation.
4. The possibility of the condition of the line interior changing through scraping, inhibiting, change of products pumped, etc.

The "C" factor gradient as here used refers to a change in the interior condition of the line from one pumping station to the next downstream station, as reflected by the value of "C" in the Hazen and Williams formula for line capacity. A section near refinery origin will likely have the lowest "C" in the high-pressure or originating end, especially if the line has not been inhibited and corrosive carryover in the product has pitted the interior of the pipe most progressively nearest origin. Sections more remote from refinery origin are likely to have an opposite gradient, that is, the highest "C" factor in the high-pressure or upstream end of the section. Possible explanation for this is:

(a) Line sediment in passing through the pumps is thoroughly mixed with the product and does not settle out so extensively in the first half of the section as in the last half.

(b) Scrapers are more effective in the first half of the section because they are less worn and less heavily loaded with line sediment.

Without considering other factors, the proper location for the partial loop would be in the end of the section having the lower "C" factor.

The age and condition of the line

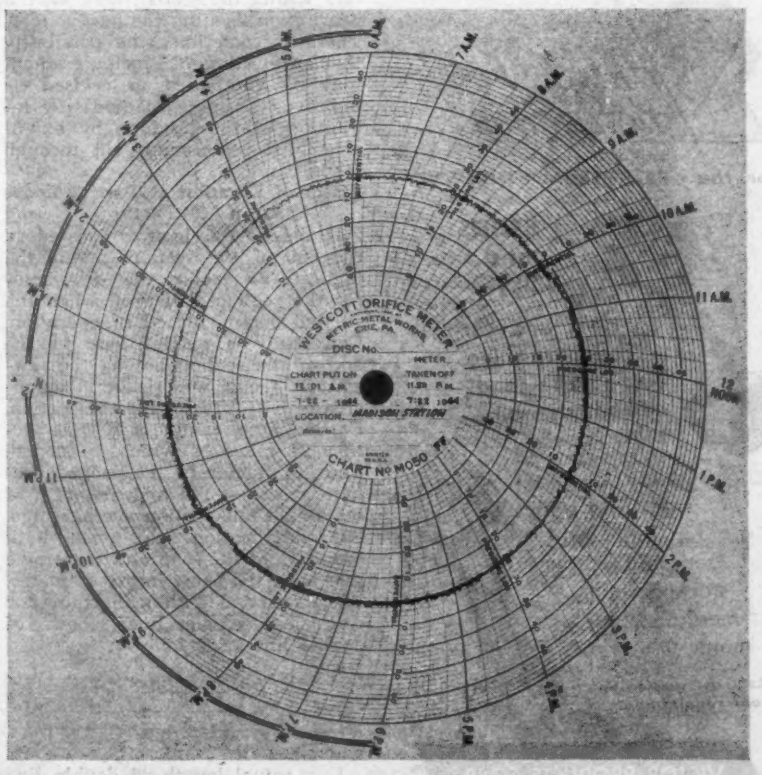

Fig. 3: Typical chart of recording manometer

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should have important consideration in locating the partial loop. Ordinarily a line being considered for partial looping will be 1 year old. A new line is built of sufficient diameter to carry the estimated load, and looping only becomes necessary some years later when the load has increased beyond the original capacity. By the time looping is necessary the old line will have been stepped up to the maximum safe operating pressure. The pipe will have deteriorated more or less, depending on degree of protection installed, and leaks and breaks will be an important factor in operation. This factor may be important enough to justify installing the partial loops in the high-pressure end of the section regardless of hydraulic considerations. As most leaks will occur in the high-pressure end of the section, location of the loop in this end will allow continued operation while repairs are being made.

Convenience of operation.—From standpoint of control, there is some advantage in having the partial loop originate in the station yard. For example, scrapers to be run in the loop can most conveniently be stored, repaired and entered into the line at the station according to a schedule. They can be removed from the trap at the end of the loop at the convenience of the operators.

Future change in relative "C" factors within the section may have a bearing on locating the partial loop. There is sometimes the possibility that an existing "C" factor gradient may be eliminated or revised by improved scraping methods, by inhibition of the product, by extensive pipe replacement or through other causes.

Effect of Location of Partial Loops on "C" Factor

If the partial loop is located in the end of the section having the highest "C" factor, the "C" factor for the section will drop when the partial loop is placed in operation. Conversely a partial loop in the end of the section having the lowest "C" factor will result in an increase in "C" factor for the section. For example, assume a 40-mile section 20 miles of which is looped. The "C" factor in the looped section averages 140 and the "C" of the single line section averages 130. For simplication, assume both branches of the loop and the single line have the same inside diameter. The Hazen and Williams formula for equivalent single line length of double line is as follows:

$$L_x = \frac{L_o d_x^{4.87}}{(d_1^{2.63} + d_2^{2.63})^{1.85}}$$

where

L_o = actual length of double line section (miles)

L_x = equivalent length of single line having same flow characteristics as the double line (miles)

d_x = inside diameter of equivalent line (inches)

d_1 = inside diameter of one loop branch (inches)

d_2 = inside diameter of second loop branch (inches)

In this case $d_x = d_1 = d_2 = 8.250$
$L_o = 20$ miles

Solving for L_x in the above formula we find the equivalent single line length for 20 miles of double line is 5.6 miles. Thus, when the formula is applied to the section we have in effect 5.6 miles with 140 "C" and 20 miles with 130 "C" or:

21.9% 140 = 30.6
78.1% 130 = 101.6

Section average 132.2

With single-line operation there are 20 miles of 140 "C" and 20 miles of 130 "C", or:

50% 140 = 70
50% 130 = 65

Section average 135

Summary

Partial loops can be installed to increase capacity to point required with a considerable saving in steel and money compared with full looping which creates excess capacity.

Phillips' experience after a year's operation of 152 miles of partial loops is that flow through the loop branches is easily controlled and that no objectional contamination results from operation of the partial loops.

In locating the partial loops consideration should be given to several factors including the "C" factor gradient, if any, in each section to be looped and the age and condition of the original line.

Location of partial loop will affect the "C" factor of the section if there is a "C" factor gradient in the original line.

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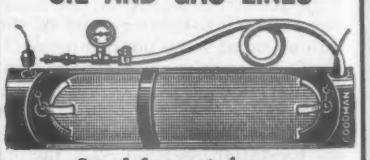

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a period of years, such a cycle must have occurred at least once in this 10-year period.

In 1939 additional anodes were installed along a section of drainage already protecting a portion of the Interstate's main line, in order to protect a parallel acquired line numbered T-9.* Fig. 3 shows the results of electrical drainage in this unusual installation. When the acquired line was added to the installation, no effort was made to balance the current flow between the pipe lines. The sustained charge imposed on the main line had created a high interface resistance at the pipe surface which opposed the excessive flow of current to it. The interface resistance of T-9 being relatively low, sufficient current for its protection flowed at the beginning. As time passed, the main line lost some of its interface resistance allowing a greater proportion of the total current to flow to it and less to T-9. This caused T-9 to be underprotected and leaks started to develop again. All of this can be seen from Fig. 3. By the insertion of proper resistance in the return circuit from the main line to the rectifiers, more current was forced to travel to T-9, thus bringing the pipe-to-soil potential difference of T-9 back to the desired 0.250-0.300 volts. It was not possible to do this by simply increasing the power output of the rectifiers since the main line became very much overprotected and T-9 remained underprotected. It is the opinion of the writers that a decrease rather than a further increase in leaks will be observed on T-9 in the seasons to come.

The charts show only a partial index of the actual effectiveness of electrical drainage. From 1931 to 1934, 5 to 8 years after construction, approximately 126,000 coupling bolts were replaced to make the transmission system safe for high pressures. It is a great contrast that after 10 years of service under cathodic protection, not one coupling bolt has been changed in "hot spots" under protection.

The authors have tried to keep abreast of the new developments and trends on other lines through the industry. In so doing they have tested various new ideas, both in the field and the laboratory. One of these ideas has been the suggested use of magnesium for anodes. It has been found that magnesium will last approximately one-third as long as zinc under similar conditions. Its galvanic efficiency determined from the actual weight loss compared to the theoretical weight loss in generating a unit of electrical current, is very low. This is due to its affinity for the nascent oxygen generated in a galvanic cell at the anodic area. Various oxygen-reducing agents have been tried as a surrounding medium on the magnesium anode, but none has been successful to date since magnesium is one of the most active oxygen-reducing agents. This is to be regretted because magnesium with its great and constant power output, should make it an excellent anode where external power is unobtainable. This magnesium-oxygen problem is one which calls for more research.

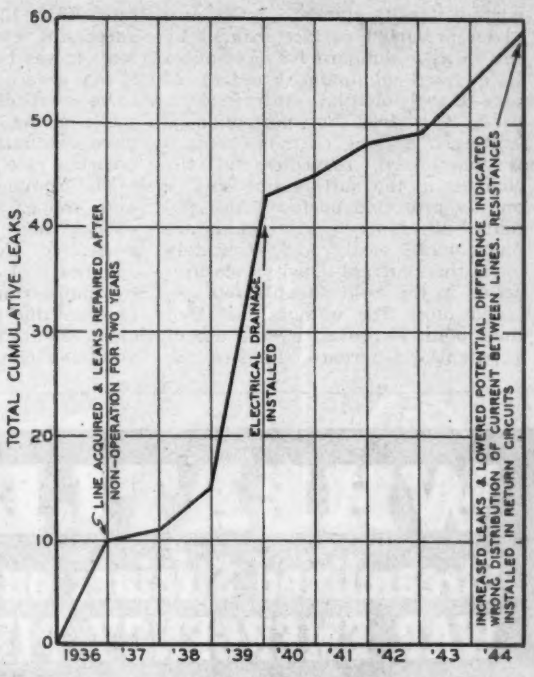

Fig. 3: Leak record of an Interstate Natural Gas Co., Inc., 16-in. o.d. line (T-9) paralleling four 13-in. lines on Fowler-to-Baton Rouge system, a distance of 3 miles

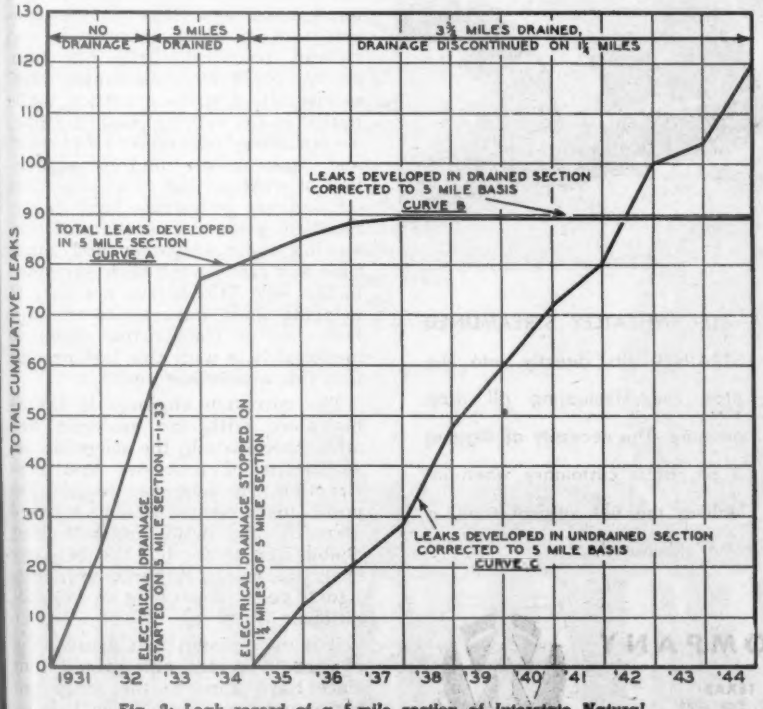

Fig. 2: Leak record of a 5-mile section of Interstate Natural Gas Co., Inc., 22-in. o.d. line from Fowler to Baton Rouge, La.

Control for Electrical Drainage

Another one of these suggestions has been, whether a control for electrical drainage should be based on pipe-to-soil-potential difference measurements or upon current density measurements. From Fig. 2 it can be seen that the power requirements for protection decrease with time. This is probably due to an actual chemical change of the surrounding soil as well as to increased polarization of the protected surface. This means that the current density necessary for protection also varies with time, so that a fixed

*"Distributed Anode Method."—O. C. Roddey and Lyle R. Sheppard, The Oil and Gas Journal, September 21, 1939.

current density standard, even on a given protected surface, cannot be set up as a standard for protection. If a fixed minimum standard of pipe-to-soil-potential difference is used, it is felt that protection is continued as long as that standard is maintained, regardless of the changes in the surrounding soil or on the protected surface. Also potential-difference measurements are much more easily and accurately made than current-density measurements in the field on unknown exposed pipe. The authors feel that their point is proved by the use of a potential-difference standard for more than 13 years in operating a successful electrical drainage system. It has been successful because it has greatly reduced and in most cases entirely eliminated leaks, while on the unprotected lines leaks have continued to occur at an increasing rate.

The comparative merits of steel and copper sulfate electrodes for measurement use have also been investigated. Copper sulfate has the advantage of high resistance, thereby minimizing the errors of measurement due to polarization. A steel electrode used with a potentiometer-voltmeter or vacuum-tube voltmeter attains the same result. There is a high potential difference existing between bright and rusty steel which causes erroneous measurements; this same condition also exists between rusty steel and copper sulfate. A correction must always be made in using copper sulfate for the potential difference between it and bright steel in soil. This correction is not a constant, as some engineers believe, but varies widely in different soils. The copper sulfate electrode also has a large temperature correction to be considered. This is often overlooked. Since steel electrode readings are lower in value than those of copper sulfate, more care is usually taken when steel electrodes are used. The steel electrode is placed at a point near the surface of the pipe, while the copper sulfate electrode must be used at some distance from the pipe surface. Thus the steel electrode measures the potential drop created by the passage of the current through the interface resistance between the pipe surface and the soil and is not so much affected by any extraneous soil resistances. Since the pipe surface is where corrosion damage occurs and where measurements should be taken, it is felt that the use of steel electrodes is quicker and more accurate than the use of copper sulfate electrodes.

Conclusions

Although the mitigation of corrosion had been in progress for many years prior to the present war, it has been and is now contributing a more important share in the conservation of steel, manpower and natural resources. This has been accomplished by maintaining steel at virtually a stable condition while buried in the soil, by requiring fewer operating personnel for repairs and replacements, and by prevention of wastage due to leakage. The oil and gas industries have recognized for years the necessity of conserving these resources and much time and effort have been expended to this end. This is true not only in bringing these minerals to the surface, but of transporting them to markets. It is with this last process that this article has dealt.

The corrosion engineer is taking his place with the geologist and other specialists in the scientific development of processes and construction. He now has at his disposal instruments which, if used correctly and with understanding, enable him to foretell the behavior of ferrous metals buried in soils from 1 to 25 years, depending on soil conditions.

It is our opinion that many miles of large-diameter pipe would long since have gone to the scrap pile had it not been for electrical drainage.

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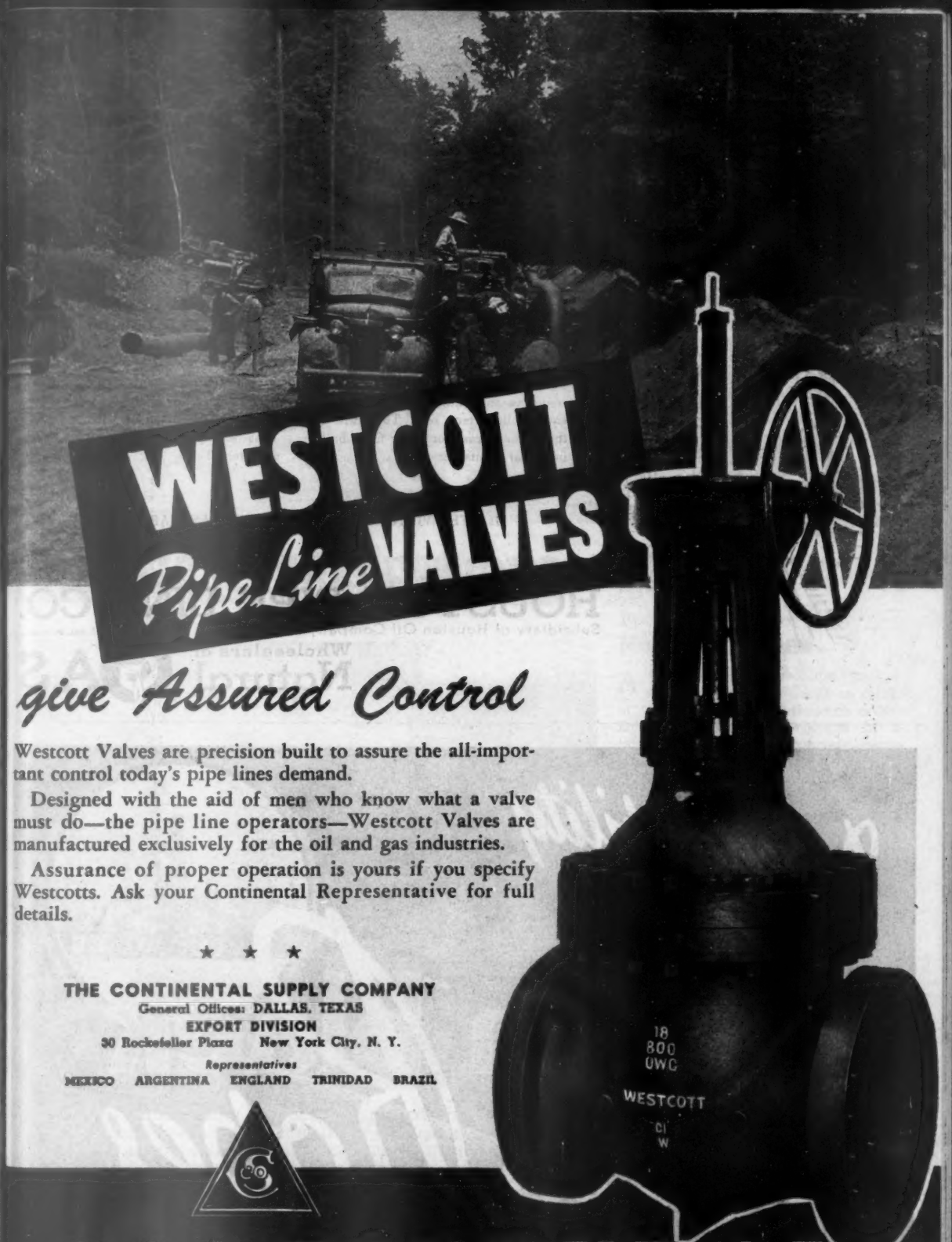

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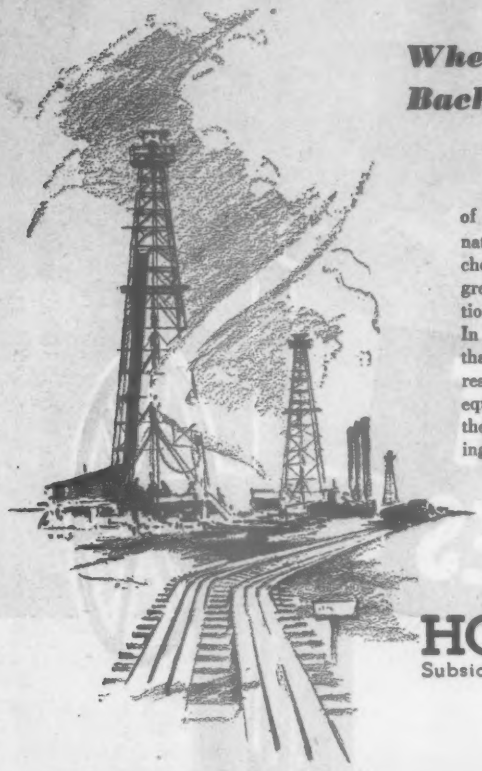

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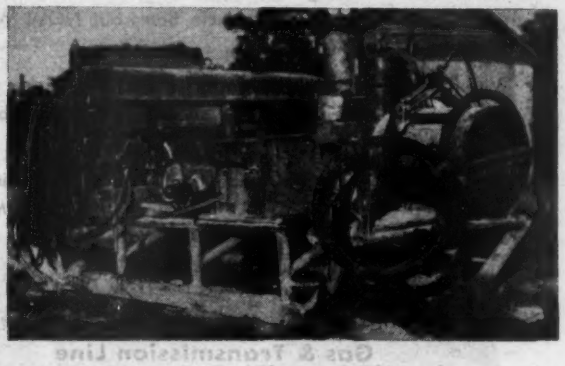
Sleds for Carrying Welding Equipment

SLEDS shown in accompanying photographs were used in Kentucky and Tennessee during the laying of Tennessee Gas & Transmission Co.'s 24-in. line. They are examples of the rugged types of sleds fabricated of welded pipe. On each of them there is a large cylindrical container, convenient for holding hose and other material. Outside of this a beveling machine may be conveniently placed, while it is transported. A welding clamp is hung handily on a hook.



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SATISFACTORY protection against flooding a crude-oil pump station of the Gulf Refining Co., Tulsa division, during a high-water period on the Mississippi River was provided by building up a wall of sandbags at the station to hold out water rising to a height of 4 ft. 4 in. above the floor. Water leaking through was pumped out by portable centrifugal pumps. Diesel-engine-driven pumping units and other station equipment resumed operation soon after the flood subsided.

All reports on the river indicated that water would not rise more than 3 ft. above the floor. It had been anticipated that provisions taken would be adequate for dealing with water at this height but it was surprising that sandbags and pumps could hold out water to the height finally reached of 4 ft. 4 in. above the floor.

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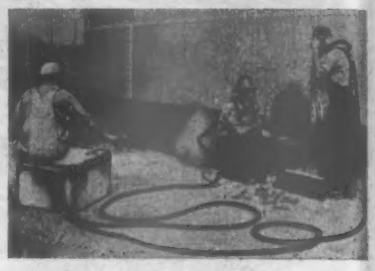

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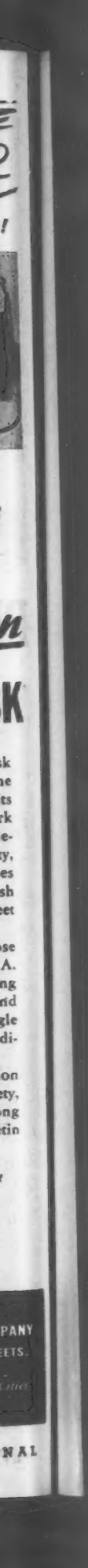
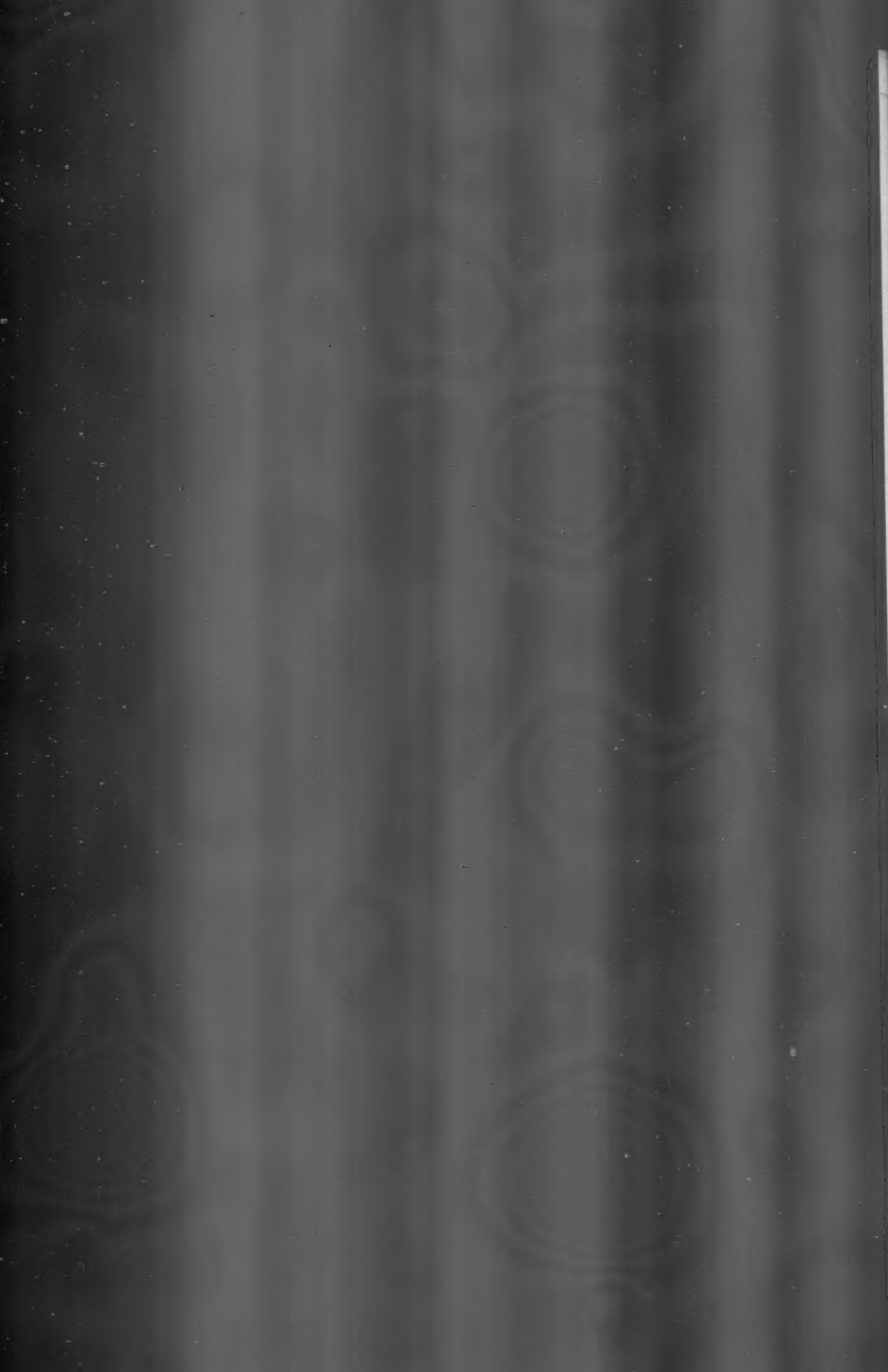




Diesel Engine Automatic Speed-Control Experience

*by J. E. O'Riordan**

Effectiveness of reliable and economical automatic control with sylphon bellows mounted on engine governor has been demonstrated by operating experience showing that suction pressure can be maintained within ½ lb. of setting of control, with an increasing pumping rate of downstream station, with elimination of packing trouble and with reduced need for station tankage.

SEVERAL articles have been written on the various methods of controlling the speed of diesel engines in pipe-line service. The most common type of method is some form of hydraulic motor operated by the pressure at the pump's suction which supplements the hand control in actuating a governor mechanism.

This article briefly covers the operating experience of Pan American Pipe Line Co. with controlling the speed of engines by means of the pumps' suction pressure. An automatic control was constructed with a sylphon bellows assembly as the hydraulic motor mounted on a UG-8 Woodward governor. This assembly controls the speed of one of two 400-hp. 327-r.p.m. Atlas engines driving a four-stage centrifugal pump. The idea of the use of the sylphon bellows in conjunction with a standard governor is not original, but has been previously used by Stanolind and Great Lakes Pipe Line companies.

Prior to installing the suction speed control, operators were instructed to maintain a suction pressure of 10 to 15 lb. by manually controlling the speed of the engines. Because of operating changes in the system, together with the human element involved, the average actual pressure maintained was much higher than the designated pressure. Frequently emergency shutdowns at the station upstream caused excessive suction pressures as the result of throttling the discharge of the boosting station. The chart in Fig. 1 shows the fluctuations of suction pressure by manually controlling the speed of the engines.

After installing the speed control system, it was possible to maintain the pressure within approximately ½ lb. of the setting of the control. The chart in Fig. 2 shows the suction pressure of the pumps while operating automatically over a 24-hour period. Investigation of the pumping records points to a 1 to 1.9 per cent increase in pumping rates from the downstream station as resulting from maintaining a constant minimum suction pressure at the automatic speed controlled station. At the time of this writing, the investigation of the effect of suction control on pumping rates is not complete, but the writer wishes to point out the trend of the effect.

During the period while manual control of engine speed was used considerable trouble was experienced with packing on the low-pressure pump. This difficulty was attributed to the fluctuating pressure to which the packing was subjected. After the control system was installed and an even pressure maintained on the stuffing boxes, the trouble disappeared. At the present time, the packing glands on the pumps have had only minor adjustment during the past 12 months.

Tankage which was originally built with the station was occasionally used when suction pressures became erratic. The very satisfactory operation of the control has made possible the removal of the tanks from service and has made them available for use in other parts of the system. The availability of the tanks during the steel shortage had particular significance.

The experience obtained from the operation of this type of control indicates that it is rugged and reliable when properly installed, and that the initial cost is insignificant in comparison with the advantages obtained therefrom.

*Mechanical superintendent, Pan American Pipe Line Co.

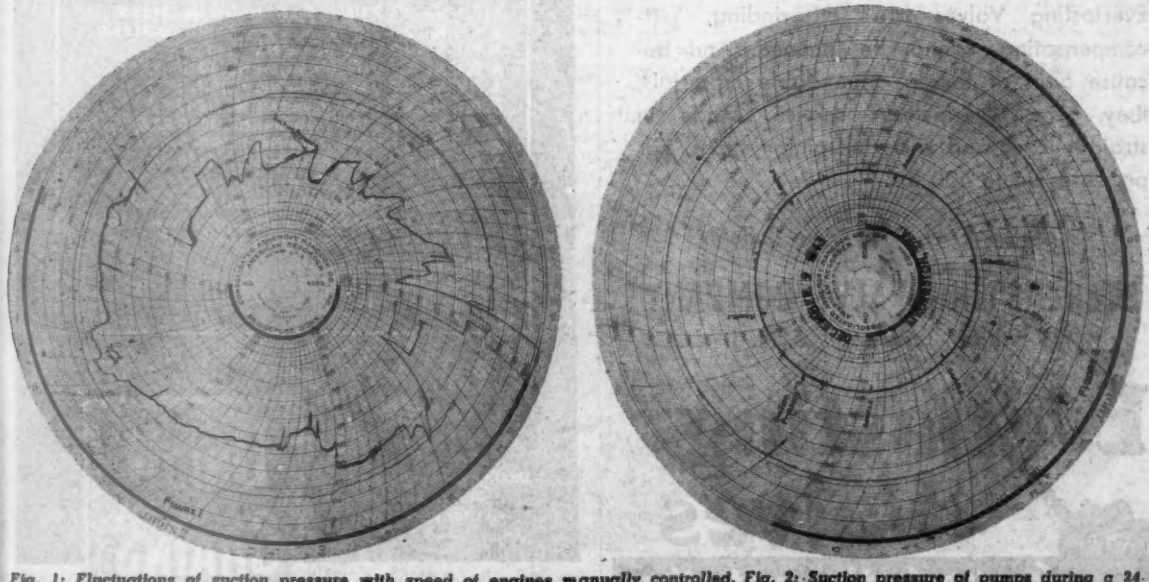
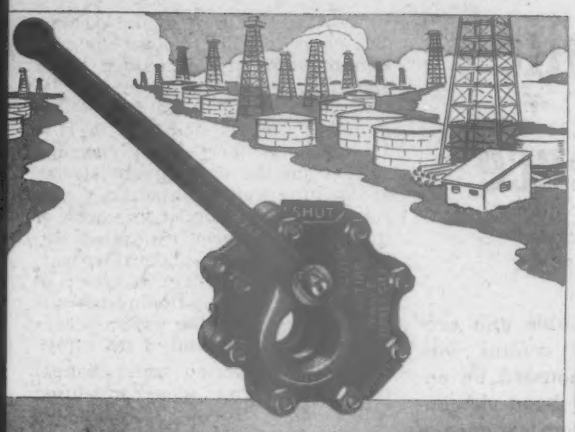


Fig. 1: Fluctuations of suction pressure with speed of engines manually controlled. Fig. 2: Suction pressure of pumps during a 24-hour period of automatic operation



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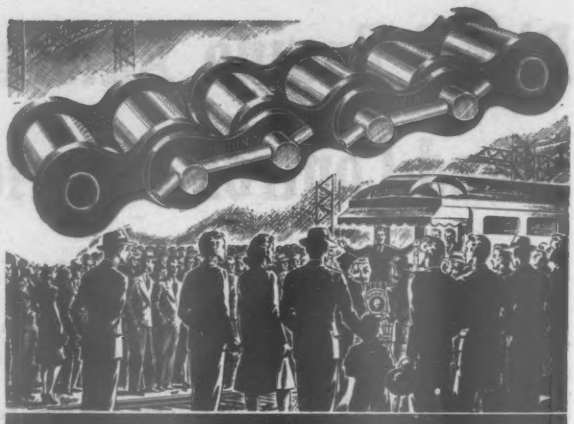

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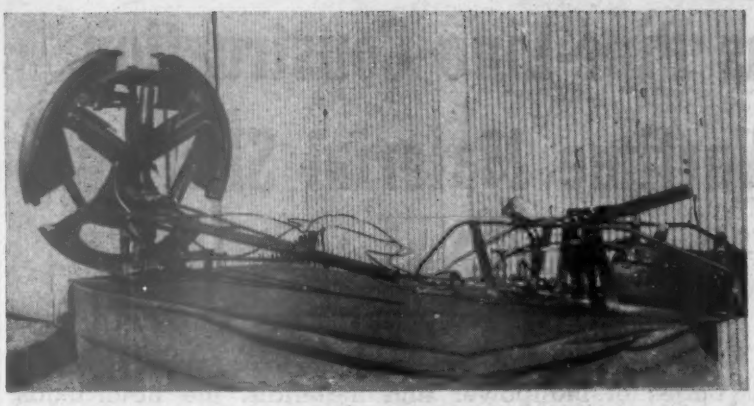

Fig. 1: Rear view of line-up clamp showing three segments fully expanded. Behind the main portion of the clamp can be seen the small jack used to hold clamp in place in one joint while it is being inserted in the adjacent joint. Only a small portion of the 40-ft. conduit is shown in picture. At right in picture are the control mechanism and pump which are attached to the other end of the 40-ft. conduit

Inside Line-Up Clamp For Large-Diameter Pipe

TO solve a problem which has arisen with the increase in tensile strength of steel which brought a trend toward thinner walls of large-diameter pipe being used to a greater extent in construction of natural-gas lines, a new hydraulic inside-line-up clamp has been developed. This device, known as the Price-Elliott inside-line-up clamp, has been used in the laying of Tennessee Gas & Transmission Co.'s 24-in. line on the sections in Mississippi and Kentucky being constructed by Bechtel-Dempsey-Price, as well as by several gangs in Tennessee and Louisiana. As a result of its use, it is claimed by its users that the clamp has increased laying and production 25 per cent.

Nearly all lines laid in the last 18 months have a wall thickness not greater than 9/32-in. and most of it is ¼-in. As much of this pipe is 24 in. and 26 in. in diameter, it has been extremely difficult to retain the circular shape of the pipe ends while it is being delivered to and strung along the right-of-way. Quite often the pipe is egg-shaped upon receipt at the railhead. In unloading and stringing such pipe must be handled very carefully to prevent indentation of the ends.

This distortion and damage to the ends has made it extremely difficult in many cases to line up the pipe for welding. Specifications call for a minimum offset in the outside circumference of the joint. The developers of the inside-line-up clamp have stated that outside clamps do not bear continuously on all surfaces of joints of pipe handled and that since openings must be left to provide for tack welding, the thin pipe tends to buckle between the bearing surfaces. Welding and laying operations, it is asserted, are delayed because of the time taken in wedging and hammering the buckles to make smooth joints. Developers of the inside clamp claim that the line up and first bead can be completed in 4 minutes for 24-in. pipe and that as a result the speed of welding and laying has been greatly increased.

The new clamp is made in three segments (Fig. 1). When hydraulically expanded it forms a perfect circle against the inside wall of the pipe. This results in an absolutely smooth joint inside the pipe. If there are any offsets because of variation in thickness of the pipe, the offsets are on the outside. By using the inside clamp there is no obstruction on the outside of the joint (Fig. 4). Consequently, the welders are able to make a complete first bead without first applying a multiple number of tacks. This is said to tend toward better welding.

Another advantage of the inside clamp is realized in the repairing of damaged pipe ends. If the ends have been indented by rough handling, the clamp is used to press out the indented portion. The usual practice has been to cut off bad ends as far back as necessary. The new clamp eliminates this waste of time and material.

A single pump operates two hydraulic jacks, the small jack being raised to hold the clamp in place while inserting it in the other joint. After the two pipe sections are placed together, the large jack is then raised to expand the three segments into a perfect circle and they hold the pipe in correct alignment.

The Price-Elliott inside-line-up clamp has been developed and is being manufactured by H. C. Price Co., Bartlesville, Okla. Patent has been applied for.

Fig. 2: Close-up view of clamp in pipe. Clamp is set but not expanded

Fig. 3: Pumping hydraulic pressure to expand clamp in joint

Fig. 4: Welding stringer bead on pipe with clamp still inside of pipe

Natural-Gas Pipe-Line Construction Overcomes Wartime Material Shortages

by Henry D. Ralph

Despite obstacles of more rigid regulation and shortages of manpower and materials, the natural-gas pipe-line systems of the nation have undergone substantial expansion since Pearl Harbor. Urgent demands for supplementary gas-fuel supplies in the eastern and western states presage an expanded construction program in the postwar era unless restrictive regulations are invoked.

WASHINGTON.—Wartime demands for fuel have required extensive construction of natural-gas pipe lines during the past 2½ years in spite of shortages of materials and manpower.

A large number of additional projects are currently in the proposal stage, but whether the natural-gas industry will expand as rapidly after the war as it has during the war is a question. The answer depends on a number of factors, chief of which are:

Regulatory policies of the Federal Power Commission; possible action by Congress to promote conservation; increasing hostility of producing states toward further export of natural gas from their boundaries; opposition of coal and railroad interests to new natural-gas transmission systems, particularly to serve "inferior" uses.

The map on page 223 and the accompanying list of construction certificates issued by Federal Power Commission would suggest that federal regulation under the Natural Gas Act is no obstacle to expansion. However, the commission's effective regulation of construction dates only from February 7, 1942, 2 months after Pearl Harbor, when Section 7(c) of the Natural Gas Act was amended. Therefore its entire regulatory experience has been dominated by the abnormal conditions caused by the war. Each of the more than 40 pipe-line projects authorized was required wholly or in chief measure to meet increased fuel demands of military installations, munitions industries, or congested war centers. In most cases the War Production Board attested to the need of additional fuel and in all cases it considered the projects sufficiently important to grant priorities for the necessary materials and equipment.

There is considerable evidence to indicate that after the war the Federal Power Commission may swing toward a policy of rather strict conservation of natural-gas reserves and may refuse to grant certificates of public convenience and necessity for the construction of new transmission lines where it is proposed to use the gas for inferior uses, such as under boilers, where some other fuel would serve the purpose.

The commission has hinted that such legislation would be desirable, and it has endorsed a resolution now pending in Congress, introduced by Sen. John H. Overton of Louisiana, which would direct it to make a survey of natural-gas reserves and uses with a view to enacting appropriate legislation.

Notable Pronouncement

The commission's most notable pronouncement on this issue was its opinion of September 24, 1943, in the case of Tennessee Gas & Transmission Co., in which coal and railroad interests protested that bringing Texas gas into the Appalachian area would threaten the coal industry with ruinous competition. The commission said:

"We recognize the force of these arguments and are not unmindful of the economic and social aspects of the problem posed by these interveners. We are not authorized, however, to regulate rates for natural gas sold directly to industrial consumers, which class of gas sales furnishes the keenest competition to the coal industry. Nor does our power to suspend rates extend to indirect sales of natural gas for industrial purposes. It appears, therefore, that the Natural Gas Act does not vest this commission with complete and comprehensive authority which would permit us to act as arbiter over the end uses of natural gas."

However, on January 3, 1944, in a rate case involving the Hope Natural Gas Co., the Supreme Court used some language which appeared to suggest that the commission had more authority than it had thought it possessed. The court's opinion said: "We do not mean to suggest that Congress was unmindful of the interests of the producing states in their natural-gas supplies when it drafted the Natural Gas Act," and after referring to several provisions of the act to support this view it continued, "thus, Congress was quite aware of the interests of the producing states in their natural-gas supplies."

The influence of this decision on the commission's thinking may be seen in its opinion of April 26, 1944, when it granted a certificate to Hope and New York State natural-gas companies to construct a transmission line from West Virginia into upper New York State. This project was opposed by coal interests as a "segment of an over-all progressive encroachment of natural gas upon the commercial fields of solid fuels." FPC found that natural gas was needed in the area for war purposes and no additional local supplies were available, but it stated, referring to the Supreme Court decision:

"That considerations of conservation are material to the issuance of certificates of public convenience and necessity under Section 7 of the Natural Gas Act is not open to question. We are deeply cognizant of the necessity for conservation of the country's irreplaceable natural-gas resources."

What appears to be the fruition of this line of thought came in the commission's decision of June 10, 1944, denying an application of Memphis Natural Gas Co., a decision which some have interpreted as a complete reversal of the commission's earlier position that its jurisdiction was limited to competition between gas companies and to city-gate rates.

In this application the Memphis company sought to construct some

WAR ERA NATURAL-GAS PIPE-LINE EXPANSION
LEGEND:
9 KEY TO ACCOMPANYING PROJECT DESCRIPTION
PREWAR PIPE LINE SYSTEM
NEW PIPE LINES BUILT AND AUTHORIZED

These wartime-construction projects are summarized by operators, sizes, length, cost in most cases, and service objectives on page 288. Prewar lines in white

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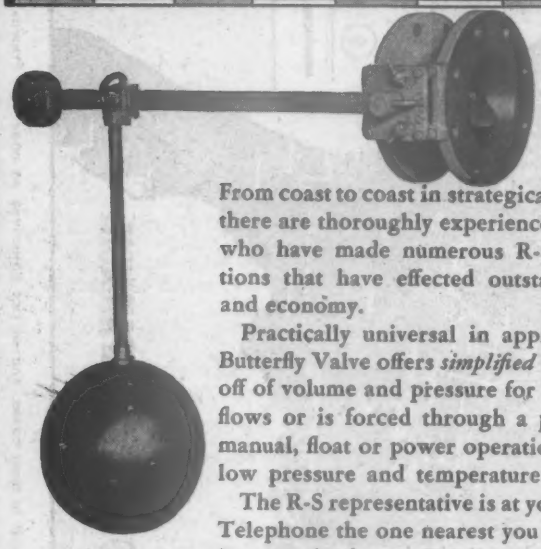

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91 miles of 18-in. loops along its existing line from the Monroe gas field in Louisiana to western Tennessee to increase its capacity by 21 million cubic feet per day, chiefly for sale in Memphis.

This Memphis decision drew a tremendous amount of interest and protest from the natural-gas industry, and the commission agreed to reconsider and reopened the case for another hearing in Memphis on September 7. At the rehearing it granted permission for the Independent Natural Gas Association of America to intervene as a party in the case, an action which some commission officials considered significant as indicating the commission's willingness to have all views discussed.

The 40-odd transmission-line construction certificates issued by the commission during the war include many of only local importance, but several received national attention.

Greatest interest centered on the shortage of natural gas in the Appalachian area, center of much war production, where demands for all industrial fuels increased tremendously. WPB early determined that additional natural gas would have to be obtained for this area as a war measure, and left it to FPC to decide ways and means. The deficiency was met by two very large projects, plus considerable subsidiary and connecting construction, to bring gas from the Hugoton field and from the Texas Gulf Coast.

Most controversial was the application of Tennessee Gas & Transmission Co. This concern was formed before the war to take gas from Louisiana into Tennessee, Kentucky and North Carolina for local sale, but never received a certificate for construction because it could not satisfy the commission's requirements as to financial ability and firm commitments for an adequate gas reserve. When WPB announced that additional gas must be found for the Appalachian area for the winter of 1944-45, this company refinanced and amended its application, proposing to obtain gas near Corpus Christi, Tex., and to extend its line to West Virginia, abandoning its original plan to serve intermediate localities. At the same time Hope Natural Gas Co. filed an application to construct a large line into Ohio from the Hugoton field.

The commission expedited its proceedings and granted Tennessee's application on condition that it deliver its gas into the Hope system for the duration of the war emergency. However, Hope's application is still pending, and there are reports that after the war either Hope or its parent, Consolidated Natural Gas Co., may seek to build a big new line into the Appalachian area from either Hugoton, Texas Gulf, or Louisiana.

As a part of the plan to relieve the shortage via the Tennessee company's new line, the commission issued a certificate to Hope and New York State Natural to build a 145-mile line to feed some of this Texas Gulf gas into upstate New York.

The other major project to aid the Appalachian area was an $11,000,000 looping job of Panhandle Eastern Pipe Line Co. virtually doubling its facilities to move Hugoton gas into Ohio and Michigan. To permit Panhandle gas to reach war industries in eastern Ohio, East Ohio Gas Co. was authorized to lay 20 miles of line to tap the Panhandle company's trunk line.

Another very large project was the 230-mile line of Cities Service from Hugoton to eastern Kansas, a project which caused much controversy in the Middle West among communities demanding that they be served by any additional natural-gas pipe-line construction in their region. Here again the demands of war industries constituted the deciding factor in the location of the line.

Also worthy of mention among the larger wartime construction projects is a series of certificates issued to United Gas Pipe Line Co. to tap new fields in southern Louisiana to augment its declining reserves and

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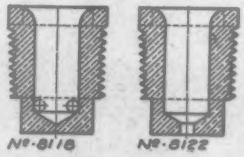
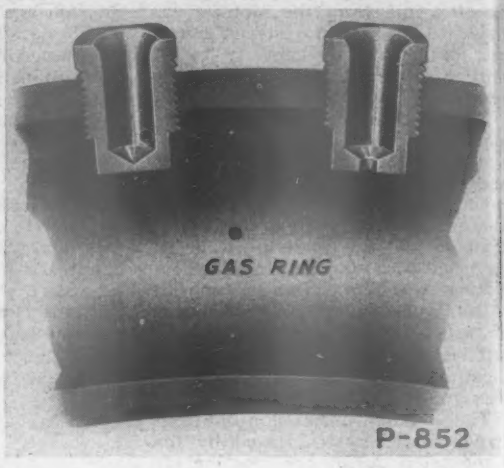


*U.S. Patent #2,160,615



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to increase its transmission facilities to serve war industries in New Orleans and the Louisiana Gulf Coast area.

Another controversial matter which may be revived after the war is an old attempt of several companies to build transmission lines into Wisconsin and Minnesota. As a wartime measure, FPC may act soon on one small feature of this old controversy, a proposal that Natural Gas Pipe Line Co. of America build a 10-mile link from its terminus near the Illinois line into Walworth County, Wisconsin, to serve Wisconsin Southern Gas Co.

After the war a great many applications are expected for construction of major transmission lines. Southern California Gas Co. and Pacific Lighting Corp. are understood to contemplate a line from the Hugoton field or West Texas to the Pacific Coast, but no formal application has yet been filed with FPC. The shortage in the Appalachian area may continue, and two applications are pending in abeyance to meet this situation. One of these is the application of Hope Natural Gas Co. for a line from Hugoton to Ohio or West Virginia; the other is an application, filed May 5, 1942, by Reserve Gas Pipe Line Co., said to be backed by strong eastern financial interests, to construct a 1,500-mile 24-in. line from a point near the Texas-Louisiana border into New York City for distribution along the Atlantic seaboard.

Recently there have been filed with the commission a group of applications from new companies proposing to tap the now-building line of Tennessee Gas & Transmission Co. to serve communities more or less tributary to its route. If granted, these projects would carry out most of the original plan of Tennessee company. Three of these were filed together by subsidiaries of Columbia Gas & Electric Corp., as follows: Cincinnati Gas Transportation Co., 400 ft. of 8-in. line near Leach, Ky.; Warfield Natural Gas Co., two 10-in. lines from Burnaugh, Ky., one 1,350 ft. west to connect with Warfield's existing system, the other 2,034 ft. east of the Big Sandy River to connect with a proposed line of United Fuel Gas Co.; United Fuel Gas Co. (a) a 10-in. line 2,000 ft. across Big Sandy River from the Warfield line to its existing 20-in. line, (b) 450 ft. of 12-in. line at Kenova to transmit gas from the Tennessee line into the system of Ohio Fuel Gas Co., and (c) 32,800 ft. of 12-in. line and 4,000 ft. of 16-in. line connecting the Tennessee line from Kanawa County, West Virginia, with United's system in Boone County, West Virginia.

Also in this group are recent applications of Kentucky Natural Gas Co. to build 18 miles of 16-in. line

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to tap the Tennessee line to serve Russellville, Ky.; Louisville Gas & Electric Co. to build 62 miles of 8-in. line to tap the Tennessee line at Calvary to serve Louisville, Ky.; Tennessee Natural Gas Lines, Inc., to build 17 miles of 10-in. line tapping the Tennessee line near Ashland City, Tenn., to serve Nashville. This latter company's application stated that as soon as materials become available it would apply for certificates to build other lines tapping the Tennessee line to serve Chattanooga, Knoxville, and other areas in Tennessee.

In addition, there are now pending before FPC a number of applications for construction certificates, most of them filed during the last few months. The most important of these are the following:

Kansas Consolidated Gas Corp. 215 miles of 18-in. line from the Hugoton field in Kansas to Wichita, Kan., at an estimated cost of $5,000,000 and capacity of 85,000,000 cu. ft. per day, to replace dwindling reserves of the Consolidated Gas Utilities Corp.

Montana-Dakota Utilities Co. 22 miles of 10-in. pipe from the company's Saco compressor to Tampico, in Valley County, Montana.

El Paso Natural Gas Co. 32 miles of 16-in. pipe from Eunice to Jal, N. M., to handle residue gas.

Memphis Natural Gas Co. 48 miles of 12-in. pipe from North Lisbon field, Claiborne Parish, to the company's Guthrie compressor station in Ouachita Parish, Louisiana.

United Natural Gas Co. 37 miles of 12-in. line from Elwood City station of Manufacturers Light & Heat Co., Beaver County, Pennsylvania, to United's Mineral Station, Venango County, Pennsylvania.

Cities Service Gas Co. 52 miles of 16-in. pipe from the Burbank field to Cotton Valley, Okla.

List of Projects

The following list, compiled from records of the Federal Power Commission, describes briefly all the projects for new pipe-line construction authorized by either temporary or permanent certificates issued by FPC from February 7, 1942, to the end of August 1944.

1. Docket G-230: Tennessee Gas & Transmission Co. Application filed February 9, 1942, amended September 3, 1943, approved September 24, 1943; covers 1,228 miles of 24 and 18-in. pipe. Estimated cost $47,500,000, including 58,000 hp. of compressors. Completion date, late 1944. From Driscoll, Tex., near Corpus Christi, to Kanova, near Charleston, W. Va., joining Cornwell compressor station of Hope Natural Gas Co. system for distribution of 207,000,000 cu. ft. per day of Texas gas in the Appalachian area.

2. Docket G-235: Natural Gas Pipe Line Co. of America. Filed March 28, 1942, approved April 17, 1942. Three spurs from the company's transmission line in northern Illinois: 10 miles of 8⅝-in. pipe to Rockford, connecting with system of Central Illinois Gas & Electric Co.; 16 miles of 4-in. connecting with the Illinois Northern Utilities Co. for distribution in DeKalb and Sycamore; 4 miles of 3-in. connecting with Illinois-Iowa Power Co. for distribution in Peru, Spring Valley, Oglesbie, and Jonesville. Completed fall of 1942.

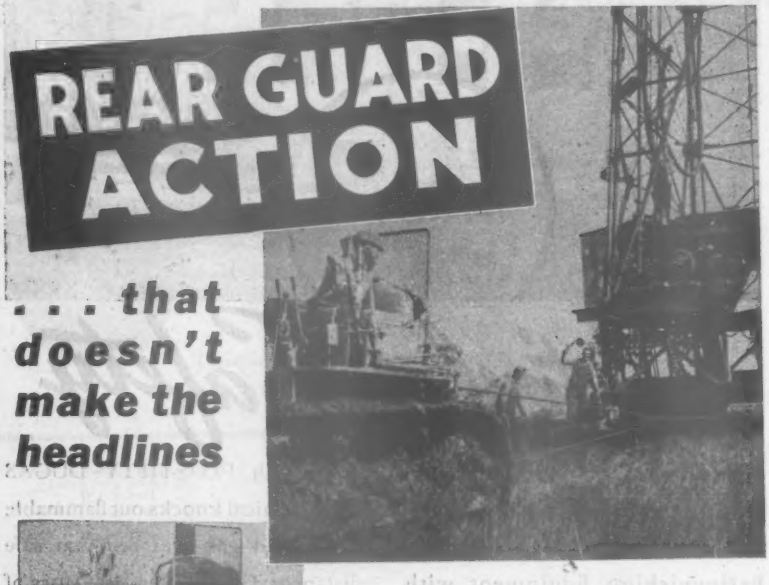
3. Docket G-397: United Gas Pipe Line Co. Filed June 19, 1942, approved August 14, 1942; 38 miles of 12¾-in. pipe. Loop United's facilities from Lake Long field, La Fourche Parish, La., to a point near St. Rose, St. Charles Parish, where the line connects with United's Baton Rouge-New Orleans line to supply additional gas required to meet war needs in New Orleans area. Estimated cost $1,090,000. Completed January 1943.

4. Docket G-398: United Gas Pipe Line Co. Filed June 19, 1942, approved August 24, 1943; 18 miles of 12¾-in. from DeLarge field, Terrebonne Parish, Louisiana, to connect with United's Lirette-Mobile line 8½ miles north of Lirette field, to supply 73,000,000 cu. ft. daily to the New Orleans area. Estimated cost, $799,000, including a dehydration plant. Completion date, September 1944.

5. Docket G-410: Panhandle Eastern Pipe Line Co. Filed August 21, 1942, approved October 2, 1942; 17 miles of 16-in. in Lucas County, Ohio, to connect the 22-in. main line of Michigan Gas Transmission Corp. (Panhandle subsidiary) to the 16-in. line of Ohio Fuel Gas Co. near Toledo. Requested by War Production Board to supply Ohio war industries. Capacity 69,000,000 cu. ft. daily. Estimated cost, $561,000 including regulator station. Completed in March 1943.

6. Docket G-419: Arkansas-Louisiana Gas Co. Filed October 3, 1942, approved October 27, 1942; 34.4 miles of 10¾-in. and 1.6 miles of 12¾-in. pipe from the Lisbon field in Claiborne and Lincoln parishes, Louisiana, to El Dorado, Ark., to serve

(Continued on page 236)



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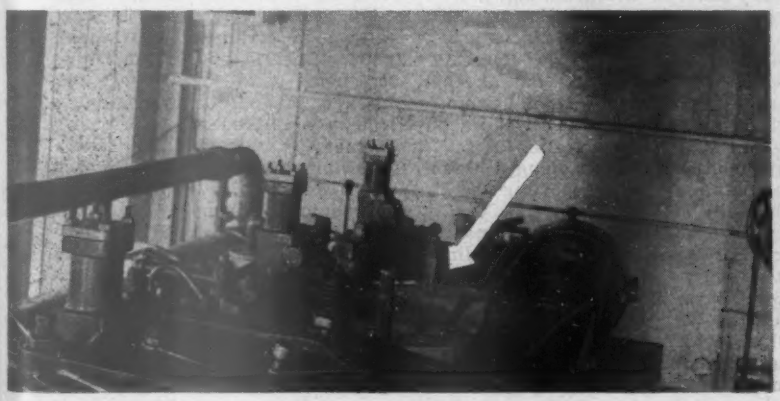
PRACTICAL SUGGESTIONS

Hydraulic Presses in Maintenance Work

THE vertical hydraulic ram of 100-ton capacity is used by the maintenance crew of a Mid-Continent crude-oil pipe line for pressing off sprockets, the halves of flexible couplings, and also for removing throws from crankshafts as well as for many other uses. The horizontal hydraulic press was fabricated at a natural-gas compressor station in Louisiana and has saved time and effort in installing and removing bushings on connecting rods and for other purposes. It is installed outside the machine shop.

Protection for Auxiliary Power Generating Unit

AT a natural-gas compressor station in a southern state where an insect called the "mud dauber" causes damage to electrical equipment a wire cage has been built to protect the electric generator of a unit driven by a vertical gas engine developing 400 hp. at 1,200 r.p.m., which is held in reserve to function in case of power failure of the transmission lines by which the station is regularly served. This cage obviates the need of having screen doors for the building which should be kept closed. Warm water from the jacket water system of the station circulates through the jacket of the engine of this auxiliary unit, maintaining a temperature at all times which is favorable for putting the engine in operation quickly.



Pan for Catching Rocker Arm Oil

A CRUDE-OIL pipe-line company has devised a pan for catching waste oil from rocker-arm shafts so that it may be diverted to cam-shaft housings. This type of pan prevents the oil from running to the floor where it must be mopped up. The photograph shows a pan on the top of a 340-hp. diesel engine during an overhaul period.

Expanded Pace of Oil Pipe-Line Building Program Is Maintained

by Henry D. Ralph

WASHINGTON. — Oil - pipe - line construction has maintained its fast wartime pace during the past 12 months, though without the dramatics and emergency pressure which characterized the pipe-line program during the first couple of years of the war.

The lines recently built or now under construction are almost entirely for the purpose of reducing tank-car movement of crude or products, to provide gathering facilities for new production, or to increase the efficiency or capacity of older systems, and their effects are chiefly local. In contrast, the initial emphasis of the so-called emergency pipe-line program was entirely on moving oil from the Mid-Continent to the eastern seaboard to replace the tanker fleet which was diverted to war service.

Missing are the spectacular big-inch lines and their attendant theatricals of racing welding crews and ceremonial first deliveries. Pipe-line construction is back to a nearly normal peacetime tempo and method of doing business. It is significant that every oil-pipe-line project begun during the past year has been financed entirely by private industry, and no more government-owned lines are under consideration.

This report on oil pipe-line construction for the past 12 months shows that the wartime construction pace has been maintained. Absence of dramatics and emergency pressure shroud scope of the work which has been chiefly aimed at increasing speed and efficiency of shipments from fields with surplus producing capacity to refining centers.

Government Retains Control

All pipe-line construction, of course, is still under the close control of the federal Government, which must authorize the use of critical materials, and even relatively minor improvements to existing systems must have the approval of the Petroleum Administration for War, although a recent amendment to PAO 15 permits construction of pipe-line projects up to $10,000 without PAW approval.

PAW assigns an individual "project number" to each construction job costing in the neighborhood of $500,000 or more, and 10 such projects have been authorized during the past 12 months. These projects total 1,137 miles of both crude and products lines, and have an estimated cost of $18,800,000, all supplied by the oil industry.

In addition there have been literally dozens of smaller pipe-line jobs for which PAW has authorized the use of materials, all designed to increase the capacity or efficiency of existing systems or to build a few miles of feeder lines or extensions.

A summary of the first 2 years of the war-emergency pipe-line program and a description of the 21 projects authorized by PAW up to last fall was carried in The Oil and Gas Journal of September 23, 1943. Since that time all projects then pending have been completed and put into operation, though not without some difficulties. For example, Project 16, the Southwest Emergency line of Defense Plant Corp. from Corpus Christi to Houston, involved conversion of an old natural-gas line, and the pipe was found to be in such bad shape that expensive and delaying reconditioning was required, but the line was finally put into operation and for several months has been doing a highly useful job of transporting 75,000 bbl. daily of West Texas and Southwest Texas crude to the Houston area for movement to the WEP line at Longview. Project 21, a 385-mile 16-in. crude line from the Slaughter field of West Texas to Drumright, Okla., which was just authorized last September, was completed without incident by Stanolind Pipe Line Co. at a cost of about $7,000,000, including extensive tank-car loading facilities at Cushing to aid eastward rail shipments.

The high spots of 1943 pipe-line construction were completion of the two giant crosscountry lines of the Government financed War Emergency Pipelines, Inc. The 24-in. crude line from Longview, Tex., to the New York and Philadelphia refining areas, was completed with the eastern leg commencing operations in August and tank-car shipments from Norris City, Ill., stopping in November 1943. It was estimated to cost $95,000,000 but final audit probably will show the cost about $80,000,000. It was engineered to move 300,000 bbl. of crude daily, but is now averaging considerably above that, as shown by the following figures for typical recent months of 1944:

WEP BIG-INCH OPERATIONS
(Figures in barrels per day)

Month—	Pumped from Longview	Delivered to Ohio Oil Co. at Enfield, Ill.	Pumped east from Norris City, Ill.	Delivered to New York and Philadelphia refineries
April	307,848	4,825	303,611	303,489
May	291,503	2,396	289,216	288,973
June	318,206	4,943	311,843	314,150
July	320,819	7,917	315,192	314,502
August	316,523	3,778	312,362	312,344

The 20-in. products line from Beaumont, Tex., to Linden, N. J., was delayed getting into operation because of defective pipe and testing troubles, and 11 miles of pipe were relaid near Chambersburg, Pa., last March. In spite of this its cost is considerably under the estimated $75,000,000, and while all bills have not yet been audited the total cost is expected to be in the neighborhood of $70,000,000. Products started moving through this line from Beaumont January 26, 1944, and first deliveries were made to the Linden terminals March 5. In addition to the extensive system of feeder lines originally designed for this line, the federal Government built 51 miles of 8-in. line from the Cities Service and Continental refineries at Lake Charles, La., to Beaumont.

The 20-in. line was designed to carry 235,000 bbl. daily of gasoline, but its deliveries have averaged something under 180,000 bbl. daily of all products. This is partly because much of the fill has been heating oil, which cannot be moved as

Major oil lines built since start of the war, including new construction, looping and projects for increasing capacity. Product lines in white

fast as gasoline, and partly because only two of the three units in each pump station are in operation due to fear of line breaks under top pressure. Nevertheless, the 20-in. line made it possible to supply East Coast requirements which could not have been met in any other way. It has been operated recently primarily as a military line, and while the largest single product moved through it has been No. 2 domestic heating oil, the bulk of its movements have been military products. After reaching full operation toward the end of March 1944, the 20-in. delivered 172,496 bbl. per day of all products during April; 156,132 bbl. per day during May; 179,333 bbl. per day during June; 179,231 bbl. per day during July, and 192,677 bbl. per day in August. The increase in August is due to the line handling a greater volume of gasoline and also to the replacing in service of three units of equipment at certain pumping stations.

Eastern Deliveries

In addition to these two WEP lines, other pipe lines built, converted, or reversed by the oil industry, continued through the year to move oil to the eastern seaboard. The following table shows, in average barrels per day, total movements of oil by pipe line into the 17 East Coast states comprising PAW's District 1:

	Crude	Products	Total
January	387,483	94,864	482,347
February	407,162	97,494	504,656
March	400,861	232,794	633,655
April	408,860	268,650	677,510
May	395,360	259,848	655,208
June	414,368	271,478	685,846
July	417,754	276,752	694,506
August	423,279	282,818	706,097

These figures do not include pipeline movements of oil entirely within District 1, nor shipments into District 2 through the branch of the Plantation pipe line which extends into Tennessee.

A summary of oil trunk pipe-line construction undertaken during the war either by the Government or with government approval is shown in the following table prepared by John E. Boice of the Transportation Division of PAW:

SUMMARY OF MILEAGE AND COSTS OF PIPE-LINE CONSTRUCTION
(Trunk Lines Only)

Twenty-seven major projects have been authorized, of which 19 have been completed, together with other miscellaneous construction. The entire program cost is estimated at $259,500,000, which has been financed as follows:

Government	$167,000,000
Private industry*	$92,500,000

Miles of new lines constructed—	Government const. comp. to date	Private industry construction: Comp. to date	Private industry construction: Under const. or authorized	Private industry construction: Total	All construction: Comp. to date	All construction: Under const. or authorized	All construction: Total
Using new pipe:							
Crude lines	1,475	1,361	536	1,897	2,836	536	3,372
Products lines	1,729	415	171	586	2,144	171	2,315
Total new pipe	3,204	1,776	707	2,483	4,980	707	5,687
Using second-hand pipe:							
Crude lines	37	1,401	15	1,416	1,438	15	1,459
Products lines	455	1,028	2	1,030	1,483	2	1,485
Total second-hand pipe	492	2,429	17	2,446	2,921	17	2,938
Total new construction	3,696	4,205	724	4,929	7,907	724	8,625
Existing pipe lines reversed and, in some cases, converted from former service	....	3,366	44	3,410	3,366	44	3,410
Conversion of natural gas lines to oil service	151	285	....	285	436	....	436
Total mileage (all classes)†	3,847	7,856	768	8,624	11,703	768	12,471

*Includes estimated $11,500,000 expended for miscellaneous station and terminal facilities. †Includes 1,283 miles of loops laid along existing pipe lines.

No big new pipe-line projects are under consideration as this is written. Several ambitious proposals made during the past year or so have been turned down on the grounds that they would not contribute sufficiently to the war program in view of the amounts of materials and manpower required, for example, a proposal to construct a crude line from West Texas to the Los Angeles refining area.

Major pipe-line construction during the remainder of the war probably will be dictated by discoveries of new crude supplies. Much of this may be in Mississippi if production continues to increase there, and in California, where Elk Hills outlets are to be provided for the 65,000 bbl. of crude daily which the Navy intends to produce from its petroleum reserve.

Of the 65,000 bbl. from Elk Hills, 15,000 bbl. will be owned by Standard Oil Co. of California which has adequate facilities for handling this amount. New lines for handling 50,000 bbl. which the Navy expects to obtain as its share of the Elk Hills production will be constructed as follows:

Union Oil Co. of California will lay a 9-mile 8-in. line from Taft, Calif., to connect with its existing line to Port San Luis to move 25,000 bbl. daily. Estimated cost of project $155,000.

The Texas Co. will lay 61 miles of 10-in. from Buena Vista tank farm of Standard Oil Co. of California to the Valley Pipe Line in Kings County to move 20,000 bbl. daily. Estimated cost of project $1,459,237.

General Petroleum Corp. will lay 15,000 ft. of 6-in. from the Buena Vista tank farm to connect with its system extending from Torrance, Calif., as well as 88,700 ft. of 6-in. loops along its line between Lebec and Torrance to handle 5,000 bbl. daily. Estimated project cost $287,225.

Summary of Projects

Brief descriptions follow of each of the 10 numbered oil-line projects approved by PAW since September 1943:

Project 22. Magnolia Pipe Line Co., new crude line, 335 miles of new 12-in. pipe from Midland to Corsicana, Texas, parallel to an existing 8-in. line of that company and tied into existing pumping stations to which some new equipment was added. Completed March 1944. Capacity 40,000 to 42,000 bbl. of crude daily. Project also included 46 miles of 8-in. second-hand pipe for looping the Magnolia line feeding into Midland from Seminole. Cost of entire project approximately $6,000,000, privately financed. The old and new lines together are delivering about 71,000 bbl. daily of West Texas crude to Corsicana, where most of it moves to Gulf Coast refineries through existing systems but some moves north through Fort Worth into Oklahoma.

Project 23. Yale Oil Pipelines, Inc., 80 miles of new 6-in. and 8-in. pipe to take crude from the Elk Basin oil field near the Wyoming line in Montana to refineries in Laurel and Billings, Mont. Three pumping stations, at Elk Basin field, Warren, and Yellowstone River just south of Billings. Project consists of 6-in. line from Elk Basin field to Warren, 8-in. line from Warren to Yellowstone River station, and 6-in. line from Laurel through Yellowstone River station to Billings. Capacity 12,000 bbl. daily in 6-in. section, 18,000 bbl. daily in 8-in. section. Estimated cost, $1,000,000, privately financed. Completed August 1944. From the Yellowstone River station crude can move either west to Laurel or east to Billings. Oklahoma Pipe Line Co. is now building 7 miles of 8-in. line from Frannie to Warren to feed into the Yale line, and Ohio Oil Co. is building 15 miles of 6-in. line from Byron to Frannie to join the Oklahoma line; these two feeders will increase the amount of crude reaching Laurel and Billings refineries by pipe line.

Project 24. Stanolind Pipe Line Co., 232 miles of 12-in. new pipe from Elk Basin field, Wyoming, to Casper, Wyo. Two pumping stations, at Elk Basin and Little

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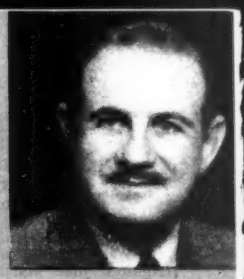

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J. B. Northcott
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Buffalo. Capacity, 15,000 bbl. daily of crude. Completion due September 30, 1944. Estimated cost, $4,500,000, privately financed. Line will serve various Wyoming fields and at Casper joins Stanolind's old line to Missouri.

Project 25. Ohio Oil Co., 115 miles of new 8-in. pipe from the company's refinery at Robinson, Ill., to Indianapolis, where a truck terminal is being erected. One pumping station, at Robinson. Construction just starting, completion due early in November 1944. Estimated cost, $1,300,000, privately financed. Line will deliver 16,000 bbl. daily of products to Indianapolis for local distribution.

Project 26. Pan American Pipe Line Co., 36 miles of new 8-in. pipe from Willamar oil field to Port Isabel, Tex. One pumping station, at Willamar. Estimated cost, $500,000. Pipe already laid, but delivery of pumping equipment delayed. Capacity, 5,000 bbl. daily of crude initially; with additional pumping equipment line could handle 20,000 bbl. daily. At Port Isabel the crude will be delivered to tankers for shipment to Texas City, Savannah, and Baltimore. The company is also building an extensive gathering-line system in the Willamar field.

Project 27. Gulf Refining Co., 75 miles of 10-in. loops to the company's' West Texas line between Judkins, near Midland, and Weatherford, Tex.; 13 miles of 8-in. loop between Saltillo and Big Sandy; and a new 28-mile, 8-in. line from Big Sandy to Longview, Tex. All new pipe. No new pumping stations. Estimated cost, $1,500,000, privately financed. Completed May 1944. The loops add about 11,000 bbl. daily to the capacity of the company's line for moving West Texas crude. The new line from Big Sandy is delivering 25,000 bbl. daily of West Texas crude to the War Emergency Pipeline at Longview.

Project 28. Texas Pipe Line Co., 34-mile, 6-in. products line, second-hand pipe, from the company's refinery at Lockport, Ill., to East Chicago (Indiana Harbor), Ind. One pumping station, at Lockport. Capacity, 18,500 to 20,000 bbl. daily of products. Estimated cost, $450,000. privately financed. Completed August 1944. Line serves a Texas Co. water terminal on Lake Michigan for distribution by barge and lake tanker, and near East Chicago will deliver part of its load into the new Sinclair pipe line from East Chicago to Toledo. An old line may be tied in to draw products from the Globe refinery at Lemont, Ill.

Project 29. Colonial Beacon Oil Co., 12 miles of 6-in. products line from Everett (Boston Harbor) west to Waltham, Mass., and 23 miles of 4-in. line from Waltham north to Methuen, near Lawrence, Mass. One pumping station, at Everett. Estimated cost, $550,000, privately financed. Construction due to start in September on delivery of new pipe from the mills, and completion scheduled for late fall. Line will have capacity of 18,000 bbl. daily out of Everett and 7,000 bbl. daily from Waltham to Lawrence. At Waltham the line connects with an existing products line of Shell Oil Co., Inc., from Fall River to West Boylston, and the two systems will be operated jointly for products distribution to truck terminals in Massachusetts.

Project 30. Stanolind Pipe Line Co., three loops of new 16-in. pipe, totaling 41 miles, replacing smaller pipe in the company's crude trunk line between Drumright, Okla., and Sycamore, Kans., and additional tankage facilities at Freeman and LaPlatta, Mo. Estimated cost, $1,500,000, privately financed. Completion scheduled for late September 1944. The improvements will increase from 124,000 to 134,000 bbl. daily the crude carrying capacity of the main Stanolind line from Oklahoma to Whiting, Ind., which will be necessary if crude deliveries through the Slaughter line from West Texas are stepped up as anticipated.

Project 31. Utah Oil Refining Co., 112 miles of new 6-in. crude line from the Iles Dome pool, Moffat County, Colorado, north to Wamsutter station, Sweetwater County, Wyoming, to connect with existing crude line of Utah company from Ft. Laramie, Wyo., to Salt Lake City, Utah. Estimated cost, $1,500,000, privately financed. Delivery of pipe scheduled for September, and completion due by the end of December 1944. At present, crude from this area is being shipped by tank car to refineries at Salt Lake City. The new line will connect with two short feeder lines connecting the Iles Dome and Wilson Creek fields to Craig, Colo., a 4-in. line of Texas Co., and a 4-in. line of Stanolind Oil & Gas Co. The Stanolind pumping station will be used as the initial station for the new line, and additional pumping equipment will be installed in Utah's stations at Wamsutter and Granger, Wyo.

Gas Line Operations Overcome Shortages

(Continued from page 228)

an industrial customer. Estimated cost, $425,000.

7. Docket G-435: Hope Natural Gas Co. Filed November 30, 1942, approved December 4, 1942; 9.8 miles of 10-in. to increase the capacity of the Bridgeport, W. Va., gas storage area. Estimated cost $240,137, including 1,000-hp. compressor capacity.

8. Docket G-458: The East Ohio Gas Co. Filed March 24, 1943, approved November 30, 1943; 120 miles of 20-in. in Ohio from Panhandle Eastern Pipe Line Co.'s line at Maumee, Lucas County, to Ohio's line in Summit County between Akron and Cleveland, to deliver Texas and Oklahoma gas for Ohio war industries because of declining Appalachian supplies. Capacity 72,000,000 to 81,000,000 cu. ft. daily. Estimated cost, $2,868,000.

9. Docket G-459: Panhandle Eastern Pipe Line Co. Filed March 25, 1943, approved September 21, 1943; 121 miles of 26-in., 35 miles of 22-in., and 87 miles of 24-in. pipe, completing looping of main transmission line from Texas to Michigan. Estimated cost, $11,000,000, including 22,000 hp. additional compressor capacity.

10. Docket G-465. Northern Natural Gas Co. Filed April 15, 1943, approved October 26, 1943; 25.1 miles of 24-in. pipe, looping main line in Rush and Barton counties, Kansas, to increase capacity for Hugoton and Panhandle gas. Estimated cost, $1,000,000, including 1,000 hp. additional compressor capacity.

11. Docket G-468: Interstate Natural Gas Co., Inc. Filed April 20, 1943, approved June 30, 1943; 5 miles of 16-in., looping the main line in Monroe field, Louisiana, from DeSaire station to Brock station. Estimated cost, $335,000, including 3,000 hp. additional compressor capacity.

12. Docket G-476: Northern Natural Gas Co. Filed May 4, 1943, approved October 26, 1943; 31.4 miles of 20 and 24-in. pipe. Loops near Sublett, Millinville and Bushton, Kans. Estimated cost $562,420, including 3,100 hp. additional compressor capacity.

13. Dockets G-482 and G-483: Joint project, filed July 3, 1943, approved October 5, 1943. Prince George's Gas Corp.; 14 miles of 16-in. line from Rockville, Md., to District of Columbia, at estimated cost of $395,500; Washington Gas Light Co., 10.2 miles of 16-in. from District of Columbia to Alexandria, Va., at estimated cost of $755,300.

14. Dockets G-488 and G-493: Cities Service Co. and subsidiaries. Filed July 27, 1943, approved September 30, 1943; 230 miles of 26-in. Hugoton field to eastern Kansas. Cities Service Transportation & Chemical Co. to construct a trunk line from Hugoton gas field near Guymon, Okla., to Blackwell compressor station of Cities Service Gas Co., Kay County, Oklahoma; 8,000-hp. compressor station at Guymon; gathering lines in Hugoton field and telephone facilities; estimated cost $10,635,000. Cities Service Gas Co. to construct 35 miles of 12-in. loop between Burbank and Tallant, Okla.; 11 miles of 20-in. loop on its 18-in. tie-over line south of Wichita, Kans.; 2 miles of 8-in. line to serve Socony-Vacuum Oil Co., Inc., refinery at Augusta, Kans.; and 340-hp. additional capacity at Saginaw compressor station, Newton County, Missouri; at total estimated cost of $1,098,000. The combined projects are to supply additional gas to eastern section of Cities Service distributing system in Kansas. Original plan was for initial capacity through Hugoton line of 140,000,000 cu. ft. daily, increased by additional compressor capacity to 220,000,000 cu. ft. in 1945 and to 240,000,000 cu. ft. in 1946. (See Dockets G-526 and G-527.)

15. Docket G-492: United Gas Pipe Line Co. Filed August 3, 1943, approved October 8, 1943; 18 miles of 16-in. to provide a second loop in the Lake Long-St. Rose line in Louisiana. Estimated cost $882,000.

16. Dockets G-507 and G-508: Hope Natural Gas Co. and New York State Natural Gas Co. Filed November 15, 1943, approved April 26, 1944; 145 miles of 12¾-in., from Hastings, W. Va., to Pew, Pa., station connection with New York State existing system; to supply Texas gas via Tennessee Gas & Transmission Co. line to the upstate New York-Pennsylvania area. Capacity, 50,000,000 cu. ft. daily. Completion date, November 1944. Estimated cost, $3,474,000, including two compressor units.

17. Docket G-510: Manufacturers Light & Heat Co. Filed November 29, 1943, approved January 22, 1944; 23 miles of 16-in., 5 miles of 12-in., 0.2 mile of 20-in., to provide a line from Marshall County, West Virginia, to Washington County, Pennsylvania, with branches to supply several Pennsylvania communities with Texas gas via the Tennessee Gas & Transmission line. Estimated cost, $1,754,000, including 6,100-hp. compressor capacity.

18. Docket G-525: Kansas-Nebraska Natural Gas Co., Inc. Filed February 10, 1944, approved April 20, 1944; 156 miles of pipe, including 41 miles of 18-in., 100 miles of 12¾-in., and 15 miles of 8⅝-in. loops, constituting a new line from Hugoton field to Stockton, Kans. Completion date, November 1944. Estimated cost, $2,343,000, including four 500-hp. compressors.

19. Docket G-526: Cities Service Gas Co. Filed February 15, 1944, approved June 23, 1944; 35 miles of 16-in. loop, from Blackwell to Burbank, Okla., in connection with new Hugoton line, to provide additional facilities for transmission of gas from western to eastern portions of Cities Service system in Kansas area. Completion date, December 1944. Estimated cost $724,300, including cooling tower and miscellaneous equipment in Blackwell station.

20. Docket G-527: Cities Service Transportation & Chemical Co. Filed February 22, 1944, approved August 1, 1944; 43 miles of feeder lines and 71,000-hp. additional compressor capacity in Guymon station to increase capacity of new Hugoton line to 213,000,000 cu. ft. daily. Completion date, December 1944. Estimated cost, $1,886,720.

Looping, Extension Projects

21. Panhandle Eastern Pipe Line Co. laid 235 miles of 12 to 20-in. in Michigan.

22. Lone Star Gas Co., 82 miles including 16 and 20-in. pipe in East Texas.

23. Arkansas-Louisiana Gas Co., 93 miles 12 and 18-in., Magnolia, Lake Catherine and Bauxite, Ark., to serve wartime aluminum plant operations.

24. Oklahoma Natural Gas Co., 96 miles 12-in. to serve Camp Gruber, extending from Chickasha to Stroud, Okla.

Miscellaneous: Twenty-two projects for short connecting lines or loops. Pipe sizes range from 2 to 16-in. Combined cost, $1,148,714.

CAVITATION as a Possible Cause of INTERNAL CORROSION

by D. T. MacRoberts*

ALTHOUGH destruction of well equipment by internal corrosion is not new—extensive surveys of the matter were published by the A.P.I. in 1930[1] and before—it seems to have become more severe, or at least more observed, within the past 2 years. Absence of severe corrosion in previous years may be partially explained by the fact that the gas wells were shallower and of smaller capacity. They were produced at much lower rates than is common in new, deeper wells. There was little condensate present and water production was normally confined to the later stages of the productive life when rates of flow were very low. The problem of this corrosion is therefore particularly serious since the deeper wells of the present are called upon to produce at much higher velocities and the majority of them produce liquids along with the gas, either direct from the reservoir or condensed in the flow stream. This corrosion is particularly damaging in surface fittings and the upper portion of tubing, and is noticeably concentrated at points of pressure reduction and changes in the direction of flow. Replacement of damaged material is expensive but the danger resulting from weakening of surface fittings is more important. Failure of these fittings is a danger to personnel and may result in damage to the well and reservoir if the flow should get beyond control.

There is no clear theory as to the mechanism of this internal corrosion. It has been attributed to so many causes that it would be impossible to find any well which did not have some potentially corrosive condition. Among the explanations that have been offered are: Chemical agents such as hydrogen sulfide, salt water, oxygen, carbon dioxide; stray current electrolysis, electrolytic action between dissimilar metals, between dissimilar electrolytes, between parts of the metal under different stresses or temperatures; and static electricity discharged in the fluid. Yet the existence of corrosion is not predictable and it is not uncommon to find wells in the same field, producing under what appear to be identical conditions, with some badly corroded and others corrosion free. This suggests that there is some conditioning factor as yet unrecognized, or that part of the so-called corrosion is not electrochemical in nature at all but is a type of mechanical erosion.

The possibility that part of the observed loss of metal is mechanical is given added confirmation by the results obtained recently by Kornfeld and Suvorov of the Leningrad Physico-Technical Institute and reported in the Journal of Applied Physics for June 1944, under the title: "On the Destructive Action of Cavitation."[2] The attention of the industry is directed to this interesting and lucidly written article.

Cavitation was first observed by Reynolds about 1894.[3] Water flowing in a tube with a local constriction was observed to form bubbles due to the drop in pressure when the velocity increased in the narrow portion of the tube (the Bernoulli effect). These practically empty bubbles collapsed when they reached a region of increased pressure. Some years later a British Admiralty commission, appointed to investigate an unusual and rapid destruction of propellors on high-speed ships, came to the conclusion that the repeated hydraulic blows resulting from formation and collapse of cavities (the bubbles observed by Reynolds) were the cause of the destruction. Similar damage was found in hydrotechnical devices. To explain this erosion Cook[4] and Rayleigh[5] developed the theory that during the collapse of cavities located on or near the surface of the metal very high pressures may arise, reaching possibly several thousand atmospheres. Microscopic examination of damaged specimens showed metal failures indicating impulsive pressures of the order of several thousand atmospheres, but no direct measurement of the pressures or of the rates of collapse of the bubbles was available prior to the work of Kornfeld and Suvorov.

Fig. 1: An example of the destruction of flow-bean tips

Research Conclusions

The Russian investigators employed the Gaines magnetostriction oscillator to induce cavitation on the end of a nickel rod. Bubble formation and rapid erosion of the metal had been previously reported by Gaines[6] while investigating the effects of intense audible sound. By means of high-speed photography Kornfeld and Suvorov were able to observe the formation and contraction of the bubbles. Their conclusions are of particular interest:

". . . the destructive action of cavities must be ascribed to the direct blow of water against the surface of the specimen. . . ."

Therefore, although the formation of cavities may be a necessary condition in the erosion of a submerged solid, any intermittent collision between a liquid and a solid will result in erosion. Kornfeld and Suvorov cite the work of Honneger[7], Cook[8], Schwarz and Mentel[9], and Mousson[10] as examples of the same action as cavitation, but in a simpler mechanical guise. In Honneger's work the sample tested was fixed

*United Gas Pipe Line Co.

on the circumference of a disk and the disk was rotated into a jet of water, the frequency and velocity being controlled by the size of the disk and the angular velocity. " . . . when the velocity is of the order of 250m/sec. (820 ft./sec.), a hundred thousand blows, i.e., about 5 minutes rotation of the disk, are sufficient for the destruction of the most durable steel."

The impact pressure between a liquid and a solid is:

$$P \cong V\,(YB)^{1/2}$$

where P is the impact pressure
Y is the density of the liquid
B is the bulk modulus of the liquid
V is the velocity.

The bulk modulus of water is about 2 by 10^{10} dynes/sq. cm. The impact pressure, in English units of pounds per square inch with the velocity in feet per second, is, for water:

$$P \backsim 50V$$

Thus the impact pressure in the Honneger experiment cited above is about 40,000 lb. per sq. in. This is considerably below the shear strength of most steels and the destructive effect must be partly attributable to the frequency of impact and the effects of sudden loading.

Since the destructive action of cavitation is simply that of an impinging liquid moving at high velocities, erosion of the well-head fittings, and possibly of the tubing, may arise from the action of entrained or condensed water or other liquids in the gas stream. Assuming the bulk modulus of condensate to be about that of kerosene (1.6 by 10^{10} dynes/sq. cm.) condensate will be of the order of 80 per cent as effective as water.

Any cavitational effects should be first found in the pressure-reducing devices operating at high-pressure differentials. An example of the destruction of flow-bean tips is shown in the accompanying illustration. This tip was in service for about 3 months on a well producing at an average of about 7,000 M.c.f. per day with maximum rates of flow of about 20,000 M.c.f. per day. The normal pressure reduction through the bean was from 2,300 lb. to 500 lb. Flow of gas was against the tip; i.e., the tip pointed upstream.

Many of the features of interest in this example will not appear in the reproduction. However, the relative lack of damage in the end of the tip is obvious. This area was still bright but showed fine pitting under the microscope. Below this section the metal necks in from 0.4 in. to 0.32 in. and definite erosion lines are visible on the necked portion. The metal then reverts to the original contour but with about 0.2 in. removed evenly on all sides. This section is black and is covered with small pits about 1/40 in. in diameter. This pitting is continuous, the boundaries of practically every pit being formed by those of the neighboring ones. Within each of these major pits there are minute minor pits visible under about 40 x magnification. The surface has a honeycomb appearance under slight magnification with all pits falling within a small range of diameters. About 3 in. from the point this section of uniform removal gives way to an area of quite irregular pitting where most of the original metal remains. The pits in this area resemble nothing so much as those formed in iron meteorites. The metal in this region gives the appearance of having been badly distorted, almost as though by plastic flow.

In critical flow devices, such as this flow bean, the translational velocity at the throat (point of minimum area) approached the velocity of sound in the gas: for natural gas about 1,600 ft. per second. In the diverging section of the nozzle the velocity will at first increase and then decrease, the exact velocity reached depending upon the shape of the entire nozzle. Since even at the throat velocity the impact pressure of water is of the order of 80,000 lb. per sq. in., there is sufficient force to exceed the shear strength of many steels. The frequency of the impacts is beyond estimation. It seems that there is every reason to expect mechanical abrasion of critical flow devices at points downstream relative to the entrance.

Bacon[11] states: "The appearance of some attacked surfaces might lead to the assumption that erosion plays an important part in the removal of metal . . . experience . . . has indicated that the removed metal is largely in chemical solution in the produced water in most cases." Bacon also reports the finding of insoluble iron compounds in a few cases but does not specify the types of compound. The question of whether eroded iron might appear in chemical solution cannot be definitely answered. However, consideration of the nature of cavitation erosion indicates that the free iron might readily combine with any reagent present in the condensed water. If the gas entering the choke is saturated with water vapor the water will condense with the drop in temperature experienced in the adiabatic expansion through the choke. This condensed water will appear in the form of a very fine spray or fog. Any iron eroded by the action of this water should come off in very small particles, possibly of colloidal size. Such a suspension of iron would rapidly react with any reagent present in the water. Gaines[3] obtained very finely divided nickel from the water surrounding his oscillator. Poulter[12] found iron hydroxide when the oscillator was immersed in water, but metallic iron when absolute alcohol was used.

Although the translational velocities through chokes may be adequate to explain erosion, the velocity through tubing and other fittings is not high enough to result in any impact forces of destructive magnitude. The translational velocities are, however, not the microscopic velocities of any small element of the gas and its entrained liquid. It has been noted that the corrosion tends to concentrate at points of acceleration* or downstream of obstructions in the flow path. Determination of the microscopic velocities in turbulent flow are not available, but it is known from experimental and theoretical work on viscous flow past solids that a series of vortices, the Karman trail, forms in the wake of the bodies. The local velocities in these trails may be high and although any destructive action of the vortices is purely hypothetical at present it would be desirable to investigate the possibility. Any destructive action due to these eddies might come either from the direct action of the water carried by the gas or from cavitation in the film of water condensed on the walls of the pipe. Hunsaker[13] reported that repeated forces of a few thousand pounds per square inch could cause destructive cavitation.

Fortunately, mechanical equipment for the investigation of cavitation erosion is simple and inexpensive. The Honneger rotating disk is sufficient to determine the destructive action of water suspended in moving gas, if it exists. Even if only a small part of the observed loss of metal were found to be due to cavitation it would be well to recognize the fact, since it would help narrow the search for an active causative agent for the balance of the corrosion.

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*The usual statement is that the corrosion is concentrated at points of high turbulence. Since the Reynolds number characterizing the flow through the tubing and fittings is generally of the order of 10^6 to 10^7 the flow is turbulent at all points in the stream except for the laminar film next to the wall of the pipe.

Underground Cable Provides for Communication Along Pipe Lines

*by Emmett Wilson**

PRELIMINARY specifications for the telephone system to be constructed with Pan American Pipe Line Co.'s recently constructed pipe line between the Willamar oil field and Port Isabel, Tex., called for an underground system in the form of a cable. The well-known restrictions on the use of critical materials prevented the installation of such a system.

Although the cable would have been only 34 miles in length, the type of construction would be applicable to that of a system of several hundred miles by the addition of repeaters at the required intervals.

As soon as wartime restrictions on the use of critical materials are eliminated we will again consider such an underground system on new construction of pipe lines. Economy of operation and maintenance over a period of years, as well as the furnishing of trouble-free service to the operation of the pipe line, make such a system most desirable.

The cable should consist of multiple conductors, probably 4, of No. 14 AWG, or larger, annealed soft drawn copper wire, each tinned and insulated with a wall of about $\frac{1}{16}$ in. of special low-capacity rubber compound suitable for direct burial in the ground without additional protective sheaths. The conductors should be cabled together and the assembly covered with some suitable covering, such as neoprene tape and asphalt weatherproof coating, in order to protect the insulation while handling and installing. The insulation should withstand certain chemical, electrical, physical, and water absorption tests. These requirements should equal those which are required of any underground telephone cable, details of which will not be given here.

The cable should be furnished in lengths near 3,000 ft., depending on the number and size of conductors chosen, in order to facilitate handling and installation.

Loading coils should be installed in moisture-proof cases. Their locations and inductance will depend on the characteristics of the cable selected.

The completed cable should have a mutual capacity of about 0.078 mf/mile. The conductor resistance will depend on the size of wire chosen and the insulation resistance should be 500 megohms per mile or more. The circuit equivalent between the ends of the circuit should not exceed 5 db at any frequency between 300 and 2,000 cycles. The circuit should be balanced to provide for connection to other lines to permit expansion of the system.

Testing equipment should be installed at each terminal in order to keep a close check on the condition of the circuit. Test leads should be brought out in weatherproof cable terminals at various locations along the line. Portable telephones could be used at these test locations by pipe-line crews, linewalkers, and telephone repairmen in the course of their duties.

The cable should be installed directly under the pipe line in such a manner that the laying of the pipe line will not injure the insulation of the cable. The pipe-line ditching machine should be so equipped that

(Continued on page 264)

*Pan American Pipe Line Co.

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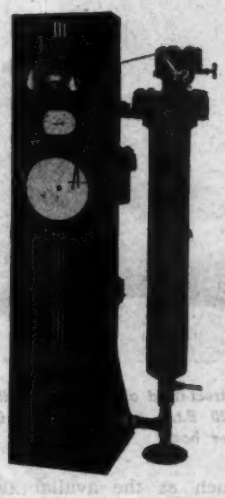
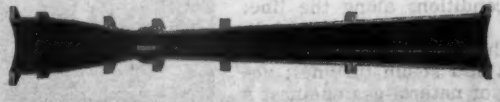
Builders Venturi Meters are giving extraordinary metering accuracy in pipe line service. The combination of a university calibrated Venturi Tube and a specially matched Type M Instrument provides a super-accurate meter.



To compensate for changes in specific gravity of oil being metered Builders Venturi Meter is equipped with hygrometer wells and automatically corrects totalizer readings. The Type M Instrument may be readily equipped for remote metering or control service.

Enduring accuracy and low maintenance cost are outstanding features of this instrument. Write for latest bulletin. Address Builders - Providence, Inc., (division of Builders Iron Foundry), 9 Codding St., Providence 1, R. I.



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BUILDERS-PROVIDENCE

Important Changes Introduced In Lines for Heavy Oils

*by Fritz Karge**

SINCE the very inception of crude-oil production in California, the petroleum industry of this state has had to battle with the problem of moving heavy, viscous oils through pipe lines from the producing fields to tidewater or to the refineries located near centers of population, hundreds of miles away from the source of the oil. As all other branches of the mechanical arts were advanced by increased knowledge, based on more accurate theory, on tests and on experience, so the art of designing and constructing such pipe lines made progress resulting in more efficient installations. A number of other factors contributed to the improvements,

Direct-fired oil heaters. Heat input 16,000,000 B.t.u. per hour, and 6,000,000 B.t.u. per hour

such as the availability of better pipe and of pipe of almost any wall thickness suitable for the varying pressure conditions along the line; the art of welding pipe joints into a line; higher efficiency of centrifugal pumps and steam turbines; development of natural-gas engines; a better knowledge of pipe-corrosion processes, and the introduction of reliable coatings for corrosion protection.

*Chief engineer, pipe-line department, Union Oil Co. of California

The author has been with Union Oil Co. of California since 1915, except for two short periods, during which time he has served in the capacity of supervisor of civil engineering design, engineer of transportation, engineer in the research and development department, and his present position as chief engineer of the pipe-line department. He is a member of the American Society of Civil Engineers, and the American Society of Mechanical Engineers.

Steam is still the most used power medium where ample water is available. The steam exhausted from the pumps heats the oil. Welded pipe lines can handle the oil at higher temperatures than screwed lines and live-steam heaters are now used in addition to exhaust-steam heaters to effect higher temperatures, since it is impracticable to raise the temperature of the oils with exhaust steam to more than about 160° F.

Pumping at higher temperatures, the viscosity of most oils is so reduced that centrifugal pumps can handle them with satisfactory efficiency and such pumps are now largely used. Steam turbines serve as drivers. Pumps and turbines turn at speeds of 3,000 to 3,800 r.p.m.; in consequence, the pumps are small and the turbines operate with relatively low water rates. Their performance is further improved when the exhaust-steam oil heaters are equipped to serve as condensers. The centrifugal pumps in successive stations operate as series pumps, balancing their work against each other, within limits. Tanks, floating on the line, so necessary with reciprocating pumps to equalize unequal pumping rates at successive stations, are unnecessary or have been replaced by small standpipes. Where cold oil from tanks must be started on its way through the line, as at the initiating pump station in the oil field, steam-engine-driven rotary pumps, that can handle viscous oils, are often used to push the oil through the heaters and into the suction of the centrifugal pumps.

Where water is not available in sufficient quantity for boiler operation, direct-fired heaters are used to bring the oil to the necessary temperature and natural-gas engines for driving all pumps. Rotary pumps are connected to gas engines through speed-reducing gears and centrifugal pumps through speed-increasing gears. Tube heaters of several designs are used and usually only a part of the oil stream is heated to so high a temperature as to give the desired pipe-line temperature after mixing the hot oil with the cold portion of the oil stream bypassing the heaters. The purpose of the split stream is reduction of pressure drop through the heater, by forcing less oil through it and that at a higher mean temperature and at a lower mean viscosity. This arrangement has proved very satisfactory and the heaters respond to the need for any required pipe-line temperature.

A careful study of the physical laws of viscous flow has led to the so-called tapered pipe line, in which a larger-diameter pipe is installed in the downstream section between each two pump stations. The oil cools as it flows along and its viscosity increases. The larger pipe is used where the smaller would give excessive pressure drops due to higher oil viscosity. This practice

Gas-engine-driven centrifugal oil pumps

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C. HOBSON DUNN, Senior Partner and founder of business which has been doing an outstanding pipe line stringing job for twenty five years.

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Our equipment consists of over a hundred trucks, caterpillars, pick-ups, and other machines essential to doing a top-flight job of stringing pipe line in any section of the United States. Just recently we added to our already modern fleet of equipment by purchasing over a quarter million dollars worth of pipe line equipment from the Oklahoma Contracting Company. Several of our present jobs include stringing pipe on the Tennessee Gas and Transmission 24-Inch Line, through the state of Louisiana; for Pan-American in the Rio Grande Valley; and a 16-inch line across the state of Kansas for the Kansas-Nebraska Natural Gas Company . . . in addition to working two gangs in Pennsylvania and New Jersey. The above jobs are being done for Midwestern Engineering Company, Ray L. Smith Construction Company, Fredell Construction Company, and Eastern Construction Company. We are prepared to give YOU the best pipe line stringing job, too.

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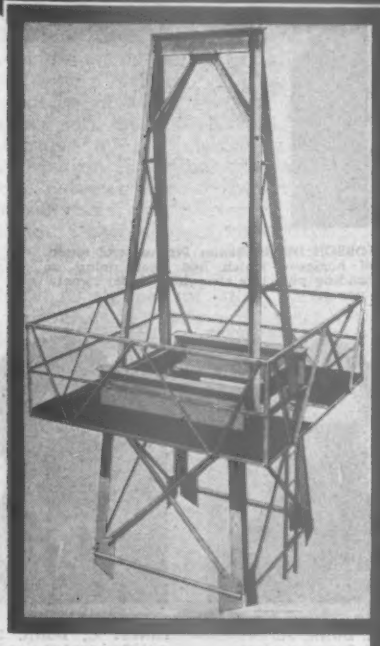

Examine the construction of Beaird derricks. At every step from top to bottom you will find extra strength built in. The sturdy gin pole, extra capacity water table, heavy 45-degree bracing, double bolt construction and perfect bearing of leg ends all mean longer life and safer operation.

Standard Beaird gin pole assembly shown at left has 15' clearance, is simple to erect and is designed to withstand horizontal as well as vertical loads. May be erected and used to raise the heavy water table beams.

Extra heavy base plate and heavy angle braces, shown below, are standard Beaird equipment. Note the bearing fitting of the leg end against base plate, assuring even distribution of leg load. Ample area and thickness of base plates avoids excessive per-square-inch loads on concrete corners.

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Beaird A. P. I. steel derricks are again available in several popular sizes. These are the same fine derricks which have gained an enviable reputation throughout the oil industry in past years. In their manufacture, engineering and design skill are combined with years of steel fabrication experience. Now, as then, the same outstanding qualities — accuracy, ease of erection, and extra strength — are built into every Beaird steel derrick.

IMMEDIATE DELIVERY

Beaird derricks in several standard sizes are now on hand at our Shreveport and Houston warehouses — available for prompt delivery.

THE J. B. BEAIRD COMPANY
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has made it possible to space the pump stations farther apart.

The A.P.I. pipe-line corrosion tests conducted in conjunction with the U. S. Bureau of Standards demonstrate that it is uneconomic to use pipe of greater wall thickness than required for the operating pressure, for the purpose of providing a longer life under corrosive conditions. This is so particularly in alkali soils where corrosion usually takes the form of concentrated pitting. It is more economic to provide a good coating supplemented by cathodic protection where conditions are very severe. On hot viscous oil lines the coating will also be beneficial in reducing heat loss.

The Santa Maria, Cat Canyon and Gato Ridge oil fields in California produce oils more viscous than any ever before handled in pipe lines. Some are of 8° A.P.I. gravity and their Saybolt viscosity is measured in days instead of in seconds. Special problems have therefore developed requiring special applications.

The west section of the Santa Maria field produces some highly emulsified oils, cutting from 30 to 40 per cent water. The emulsions are very viscous requiring excessive pumping pressure to move them through a 12-in. line to the dehydration plant. Reasoning that the oil would not take up additional water except through violent agitation, and that water forced into the line just ahead of the oil pump might form an envelop around the oil thus separating it from the pipe wall, such operation was undertaken and found to be successful. The oil is now moved in a water envelop at about one-third previous pressure.

The mixture of the oils from the various leases in the Gato Ridge district has a viscosity of 7,500 S.S.U. at 122° F. A 6-in. pipe line, 23,000 ft. long, handles this oil to an 8-in. line, in which it blends with a very much less viscous oil. The production at first was insufficient to pump continuously at a rate that would keep the 6-in. line open during wet winter months. The line had to be shut down from time to time and the oil in the line could not be permitted to cool to ground temperature. It would have been impossible to plug out the cold oil or to start pumping through the line when cold. The oil would have chilled to immovability before reaching the 8-in. line. A water tank with automatic heater was therefore installed at each end of the 6-in. line and a water pump at the tank at the delivery end, lower in elevation than the pumping end. After an oil shipment, the oil pumps clear the 6-in. line into the 8-in. line with hot water. A valve at the lower end is then closed; the water pump forces the water in the line into the upper

(Continued on page 256)

Station Instrumentation and Control—"Nerve Center" of Pipe-Line Operation

by Merritt A. Hyde*

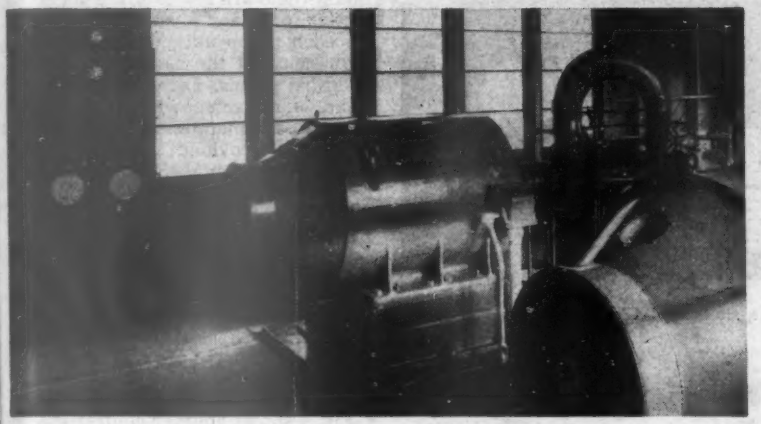


Fig. 1: Two 900-hp. units in products-line station are started and stopped from a board located in pump room convenient to manually operated pump valves

FOR most effective pipe-line operation each pumping station should have its instrumentation and control organized to function as a local "nerve center" in the system as a whole. This objective justifies thorough planning, at the time of station design, in the selection of instruments and control devices and physical arrangement.

Station design is quite variable as to the number of instruments and control devices used, depending upon the size of line, type of shipments handled, and number of delivery points.

On most trunk lines design economics, including considerations of flexibility in throughput, lead to multiunit stations, with no breakout tankage, the stations along the line operating interdependently. These conditions lead to the use of pressure-indicating gages at critical points in each station; often pressure recorders are desirable, and frequently pressure controllers are installed to reduce the work of the station personnel in maintaining pressure conditions within the prescribed limits. Lines serving multiple delivery points find recording flow meters useful as an operating aid, in addition to the integrating volumetric meters used as the basis of delivery charges.

Aside from these hydraulic quantities, it is often helpful to the station operator to have convenient indication of the position of important valves, particularly the suction and discharge valve for each pumping unit, and sometimes other major valves in the station piping. Frequently such valves are motor operated to simplify the job of the attendant.

Upon the functioning of any shutdown protective device, it is desirable to give the attendant its immediate identification. This may be accomplished conveniently by light indication.

A well-planned arrangement of the various hydraulic instruments, indicating lights, and control devices contributes greatly to efficient station operation and to coordination of the several stations on the line.

Fig. 1 shows one form of control

*Petroleum industry engineer, Westinghouse Electric & Manufacturing Co.

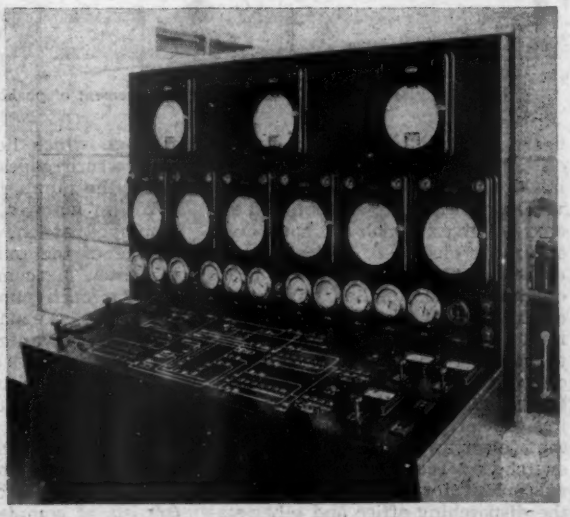


Fig. 2 (left): The operating and switchgear room is separated from the pump room shown in Fig. 1. Fig. 3 (right): This board controls two main-line pumping units and two pumps on separate branch lines, in a station of the Plantation Pipe Line

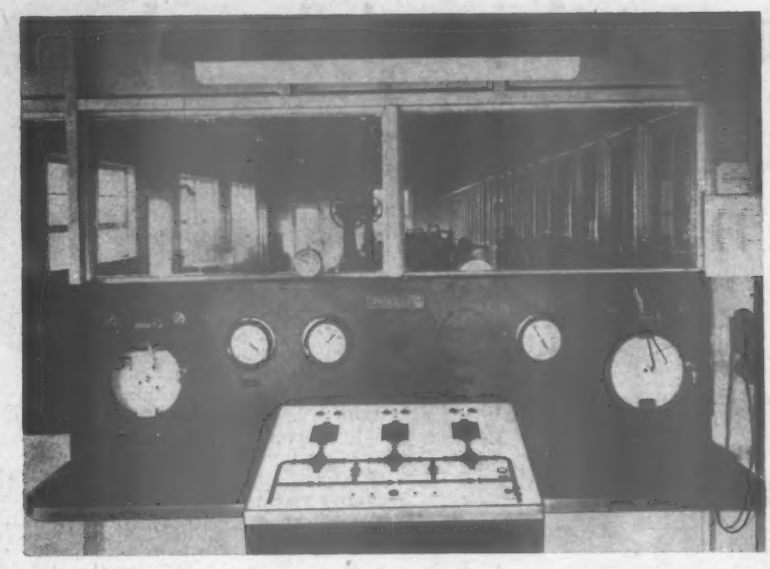


Fig. 4: Control board in 20-in. products-line stations of War Emergency Pipelines

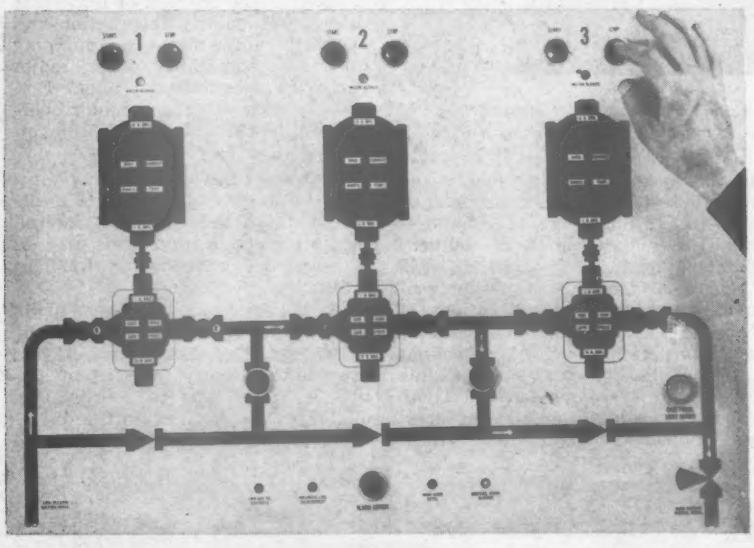


Fig. 5: This view of control desk details arrangement of pushbuttons and lights

board designed for booster stations on a refined-products line. Mounted in the pump room this board is convenient to the pump suction and discharge valves, which are hand operated. All electrical devices are of explosionproof design. This board operates in conjunction with an incoming power circuit breaker and motor starting switchgear outside the pump room in nonhazardous location. On the switchgear are mounted the indicating lights for identifying protective functions, along with the electrical instruments. The switchgear room contains teletype equipment for communication with the dispatching office and other stations on the line. At a desk in this room the operator faces a window through which he can view a row of pressure gages and, farther beyond, the pump room.

Where motor-operated valves are employed at the suction and discharge of the pumps it is possible to center the complete control system for each pump unit, including the valves, at a station control board. The most advantageous location for such centralized control is in a windowed partition between the pump room and the switchgear room.

Fig. 3 shows an installation of this type in a large products-line station serving a main line and two branch lines. This control board actually consists of completely separate sections for the hydraulic and the electrical devices. The vertical section is a gas-tight gage panel having the hydraulic instruments gasketed into the surface facing the control room. This panel is sealed into the partition and all liquid lines are in the pump-room side. The control room is maintained nonhazardous by pressuring it slightly with outside air, thus preventing possible gas seepage into this room from the pump room.

All wiring conduits entering the electrical desk section from the pump room are sealed off. This desk section provides pushbutton control for each pump unit, with automatic sequencing of the associated motor-operated valves. For each unit there is an ammeter showing motor current. A common temperature indicator is provided with selector switches for connection to thermocouples in motor windings, motor bearings, and pump parts.. Signal lights, for protective device identification and for motor-operated valves and principal hand-operated valves, are placed on the desk top in appropriate positions in a schematic diagram of the station piping.

Control Board Features

Fig. 4 shows another control board designed for products-line service. One of these boards in each station of the line controls three 1,250-hp. main-line pumping units and associated motor-operated valves. Lights for indication of valve position and protective devices are correspondingly spotted in a simplified diagram of main piping.

The desk top is a plastic sheet, bearing the diagram on its under surface. At each light location is a clear spot in the diagram, with a color disk beneath, through which the signal light shows when energized by the associated electrical circuit. Illuminated arrows in the piping diagram show at a glance the course of flow through the station, in accordance with the units in actual operation.

The glassed partition in which the control board is sealed provides ready view of the pump room and driving motors. Isolation of the control room from the rotating equipment is particularly advantageous in these stations where dispatching is performed by telephone, for with low noise level the telephone loudspeaker is easily audible in any part of the control room.

THE COVER

The photograph appearing on the cover page of this section was taken by Cleo Robertson, welding foreman, Bechtel-Dempsey-Price, during construction of a section of the Tennessee Gas & Transmission Co. 24-in. line in the rugged mountainous area of Kentucky.

Automatic Protection in The Pumping Stations of The WEP Projects

*by W. G. Taylor**

BECAUSE gasoline requires much more care in pumping-station operation, numerous safeguards in the form of automatic protection and some features of automatic operation have been provided for the 20-in. line of the War Emergency Pipelines projects.

Inasmuch as it has been the policy of War Emergency Pipelines, Inc., to confine such features to essentials, no electric interlocking has been provided between successive pumping stations along the line. Operations depending upon the action at the upstream or downstream stations are governed in accordance with the hydraulic suction and discharge conditions thus created at each station.

*Petroleum and chemical section, Industrial Engineering Division, General Electric Co.

Protective features provided in each station are listed below. The three functions which are provided for by suitable relays, are (1) sounding an alarm, (2) lighting an indicating lamp, and (3) tripping the motor-oil circuit breaker in case of indicated trouble.

Protection of Individual Pumping Units

Trouble and function performed:

High motor-punching temperature—alarm and light only.

Motor overcurrent — alarm, light and trip.

High motor-bearing temperature—alarm, light and trip.

High pump-bearing temperature—alarm, light and trip.

High pump-casing temperature—alarm, light and trip.

High pump pressure—alarm, light and sequential trip, as further described.

Undervoltage — Time-delay trip only.

Protection of Station

Trouble and function performed:

Incoming-power overcurrent — alarm, light and trip.

Low station-suction pressure — alarm, light and trip.

High-line discharge pressure — alarm, light and trip.

Low air pressure—alarm and light only.

High sump level—alarm and light only.

When the high-pump-pressure protective switch functions, it immediately shuts down the pump on the downstream side of the station, and if this does not relieve the condition, the next unit upstream in the station is shut down automatically after a time delay, adjustable from ½ to 4 seconds. If this still does not relieve the condition, the third unit is automatically shut down after a similar time delay.

Station suction and downstream line pressures are controlled by air-

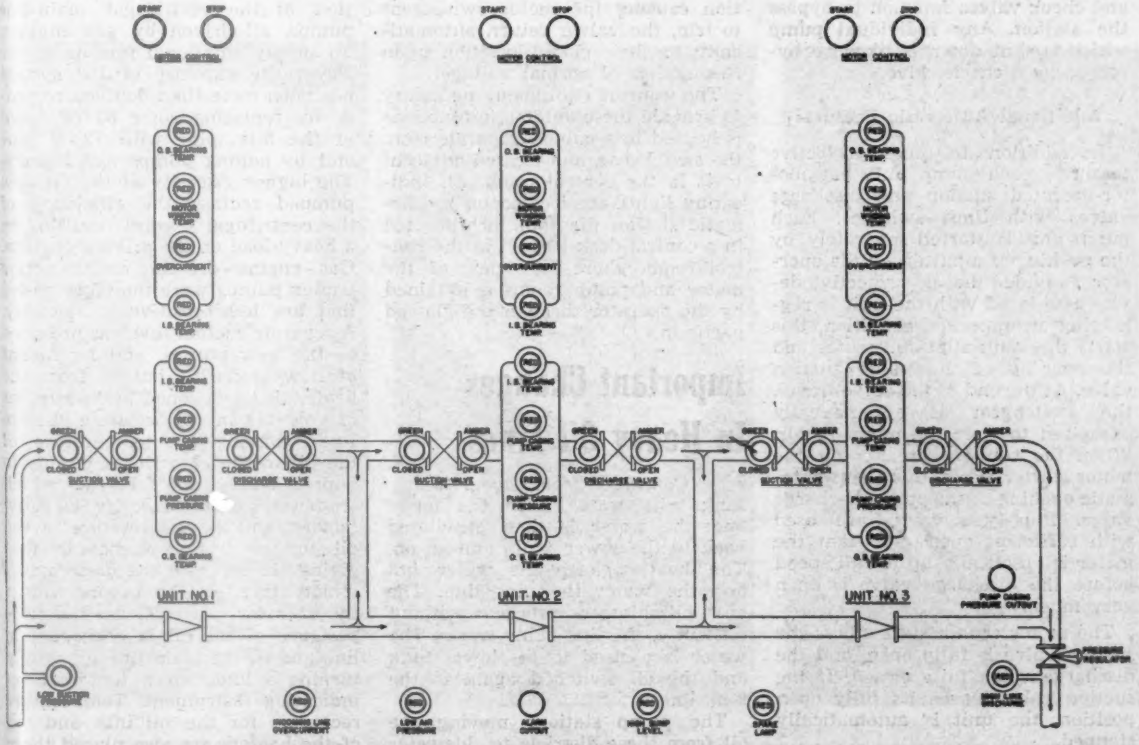


Fig. 1—Station diagram incorporated in top of control desks in pumping stations on 20-in. products line. Red indicating lamps are lighted only to show an abnormal condition. Green and amber lamps are for position indication. Arrows are lighted in accordance with the direction of flow resulting from the pumping units in actual operation

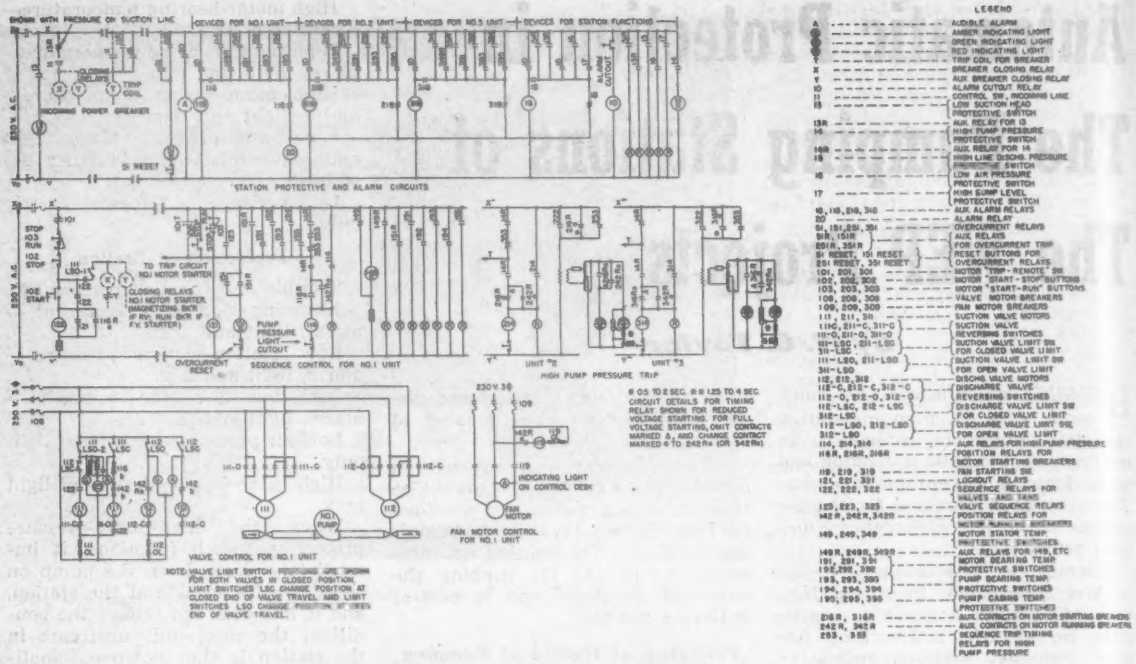

STATION PROTECTIVE AND ALARM CIRCUITS
SEQUENCE CONTROL FOR NO.1 UNIT
HIGH PUMP PRESSURE TRIP
VALVE CONTROL FOR NO.1 UNIT
FAN MOTOR CONTROL FOR NO.1 UNIT
LEGEND

Fig. 2—Schematic station sequence control diagram for 20-in. products line

operated regulators, and if the suction pressure becomes too low, or the line pressure on the discharge side too high, the entire station is automatically shut down as indicated in the foregoing tabulation, and check valves function to bypass the station. Any individual pump which is shut down is likewise bypassed by a check valve.

Additional Automatic Features

In addition to these protective features, each pump unit has motor-operated suction and discharge valves with limit switches. Each pump unit is started separately by the pushing of a button by the operator. Provided that no protective device associated with the unit is registering an abnormal condition, this starts the ventilating-fan motor and the opening of the pump suction valve. At the end of the valve travel, the switchgear is automatically energized to start the pump motor. When the running breaker on the motor starter closes, this starts automatic opening of the pump-discharge valve. Plug-type valves are used with sufficient overlap so that the motor is practically up to full speed before the discharge valve is open very much.

The motor cannot start unless the suction valve is fully open, and the discharge valve fully closed. If the suction valve leaves its fully open position, the unit is automatically stopped.

Normal stopping of each of the pump units is accomplished by pushing a button. In case of either normal or automatic abnormal shutdown, the associated ventilating fan is automatically stopped simultaneously, and the valves travel automatically and at once to their closed position. In case of power interruption causing the motor switchgear to trip, the valves return automatically to their closed position upon resumption of normal voltage.

The control equipment necessary to provide these automatic functions is housed in a cubicle separate from the switchgear, and located adjacent to it in the control room. All indicating lights are located on a schematic station diagram incorporated in a control desk located in the control room where full view of the motor and pump rooms is obtained by the operator through the glassed partition.

Important Changes In Heavy Oil Lines

(Continued from page 246)

tank with water from the lower one; the water is then gravitated back to the lower tank, and so on. The heaters keep the water hot and the water the pipe line. The next oil shipment proceeds without difficulty, the line being warm. The water is cleared to the lower tank and the oil switched again to the 8-in. line.

The pump stations moving the oil from these districts to tidewater were built some 7 years ago using an existing 8-in. pipe line. The very viscous oil from Gato Ridge was not handled at that time and the mean viscosity of the Santa Maria oil was lower than now. Rotary pumps were installed to push the cold oil from the tanks through the direct-fired heaters and into the suction of the centrifugal main-line pumps, all driven by gas engines. To supply additional fuel oil to the Navy, the capacity of the system has been more than doubled recently by replacing some 80 per cent of the 8-in. pipe with 12-in. pipe and by adding pumps and heaters. The higher viscosity of the oil now pumped reduces the efficiency of the centrifugal pumps, resulting in a heavy load on the driving engines. Gas-engine-driven single-acting triplex pumps were therefore added that are less sensitive to viscosity. A separate suction line was provided to the new pumps, and by means of flow beans the hot oil from the heaters is apportioned to the streams of cold oil in the separate suction lines bringing the temperature of the oil to the centrifugal pumps to approximately 200° F., at which temperature the viscosity is satisfactory, and the temperature of the oil to the triplex pumps to that giving the mixture the desired line temperature. At the mixing valves the operator can ascertain the temperature of the oil in each suction line and in the main line by simply turning a knob on a temperature-indicating instrument. Temperature recorders for the oil into and out of the heaters are also placed there so that a complete picture of the temperatures at all important points in the system is apparent.

Flame Priming Storage Tanks

FLAME priming is fast becoming recognized as a highly efficient and economical means for preparing steel surfaces for painting. The ease and economy of applying flame priming and the resulting high quality of the treated surfaces are such that the process is being increasingly used on many types of structural steel work, such as the storage tank shown in Fig. 1.

This application of the oxyacetylene process is designed to improve the surface to be painted as well as the conditions under which the paint is applied. The intense, quick heat of the oxyacetylene flame expands rust and loose scale, causing it to pop off the relatively unaffected metal beneath, and to drive out the surface moisture. This treatment leaves the surface clean, dry, and warm, making the paint go on faster, bond tighter, and last longer.

The flame-priming operator uses a regular heavy-duty welding blowpipe with a special flame-priming head, which has a number of closely spaced flame ports that provide a series of high-velocity, high-temperature flames. Fig. 2 shows a closeup of such a head in action. The 49 flame ports in this head are spaced ⅛ in. apart, giving a 6-in. flame coverage. The flame ports are No. 75 drill size, or 0.021 in. in diameter. Despite the extremely small port diameter, the flames are ¼ in. long, indicating the high velocity of the burning gases. Because of its design, the same head can be used to clean steel surfaces surrounding rivets. Hard-faced skids on either end of the head keep it the correct distance from the work and protect it from abrasive wear.

Attaching Head

Depending on the type of work being performed, the head is either attached directly to the blowpipe, or attached by means of an extension arm. The blowpipe is in turn connected by lengths of hose to supplies of oxygen and acetylene.

Fig. 3 shows a large storage tank being prepared for a lasting paint job. Mill scale and rust formed on the outside of the tank have to be removed by the "blasting" action of the flames. The heating head is passed rapidly over the surface. The quick heat and intense velocity of the flames instantaneously raise a superficial layer of the scale to a high temperature. The heating is so rapid that the bottom layers of the scale remain at a relatively low temperature and a brittle state. The steep thermal gradient across the thin scale sets up tremendous stresses. As a result of this and because of the brittleness of the cold underlayer, the scale pops away from the base metal.

Tightly adherent oxide scale will withstand the action of the flames. However, provided no moisture is present, such scale not only serves to protect the steel from corrosion, but also forms an ideal base upon which to apply the priming coat of paint. In fact, iron oxides are often themselves used as pigments in protective coatings, and since mill scale is an iron oxide, it exhibits similar protective properties when tightly adherent to the base metal.

After the surface has been treated, it is brushed or wiped free of loosened foreign materials; it is then painted while still warm and dry. To assure continuous operation, many companies have found it advisable to have three men working within a few feet of each other—the flame-priming operator, closely followed by a helper who brushes off the scale, and lastly the painter, who applies the protective coat to the clean, dry tank while it is ideally conditioned to receive it. Quality of results combined with great savings in time and cost can be assured by this method of steel conditioning for painting.

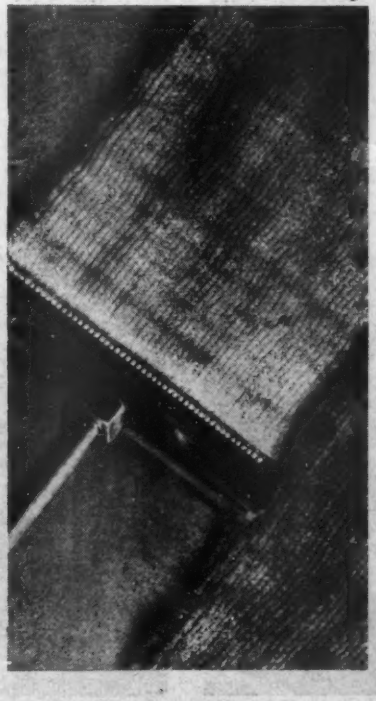


Fig. 1 (left): Oxyacetylene flame-priming adequately solves the problem of preparing structural equipment for a protective coating of paint. Fig. 2 (center): This picture shows the 6-in. flame-priming head in operation. Corners or irregular surfaces are no obstacle. Wear-resistant pads and skids protect the flame ports. Fig. 3 (right): Rust and scale on this tank are being removed by the flame-priming process. It will leave the surface warm and dry for the application of paint. (Article contributed by Linde Air Products Co.)

Arc-Welded Lines in Oil and Gas Systems

*by C. M. Taylor**

STEADY progress in the methods used for the construction of pipe lines has been a significant factor in increasing the volume of oil and gas that is now being transported by this means to vital industrial centers.

The inherent characteristics of the shielded-arc method, which greatly facilitate pipe-line construction by simplifying and speeding up the work, has resulted in the recognition of the welding process as standard practice for the majority of line contractors.

Some indication as to the increase in the flow of oil and gas through pipe lines that have largely been constructed by means of the electric arc is apparent in recent statistics released by the Bureau of Mines. The bureau's figures reveal that during 1943, the flow of motor fuel alone reached the total of 206,512,000 bbl., against 126,232,000 bbl. for the previous year, an increase of 63.60 per cent. Corresponding gains have also been made in the transportation of gas through pipe lines due to thousands of miles of additional gas-line construction.

Generally, larger sizes of pipe ranging up to 26-in. diameter have predominated for both oil and gas lines, with "stove-pipe" methods being used in many cases. This procedure is illustrated in Fig. 1 where the operator is applying the finishing overhead weld to join 16-in. diameter pipe. This work is being done on an emergency oil line reaching from Texas to Mid-Continent refineries and is one of scores of similar pipe-line projects completed during the year.

*Vice president, Lincoln Electric Co.

This particular line has a daily rated capacity of 65,000 bbl. and is 485 miles in length. Although construction did not introduce any radically new welding techniques, the procedures used represent the advances in welding that are now commonly followed in the industry.

The beveled ends of the pipe sections were first butted together using an alignment fixture, (see Fig. 1), and the joint was tack welded. Two operators then applied the stringer bead with 5/32-in. electrode, working from the top down.

Welding Procedure

The second and third beads were applied using ¼-in. electrode. All electrodes were of American Welding Society specification E-6010, with the average daily number of completed welds per operator being 16, exclusive of tack welds.

Welding of the pipe sections which were of medium-high carbon content and fairly high in manganese, was done without liner.

After completion of the welding, the pipe ends were plugged and the line was tested by injecting air at 100 lb. pressure. Absence of leakage at the joints was noted by lack of reduction in air pressure.

Reclamation and reuse of old pipe has continued at an accelerated pace due to the critical shortage of new pipe.

An example of how pipe from a 30-year-old unused gas line was used to replace badly corroded sections of a nearby oil line is typical of this type of line repair.

The gas line was first dug up and pipe sections were chosen for reuse after careful inspection. The old, threaded ends of the sections were then cut off at a 30° bevel with a flame cutter, butted together and "bell-hole" welded. Three beads were applied to the joints, the welds being thoroughly cleaned after each bead.

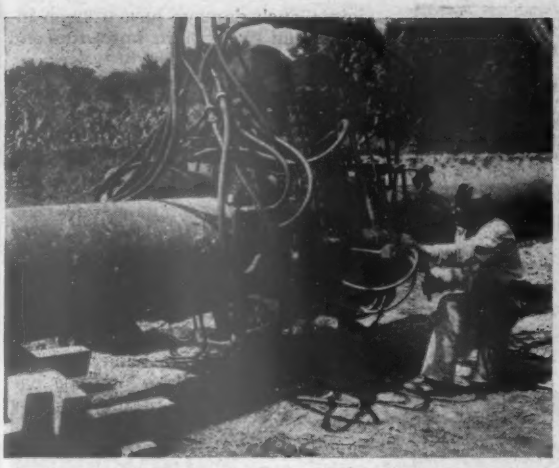
The replaced line which was several miles in length, included a canal crossing where a section of pipe was bowed up at the center to compensate for lack of support, then carried across a canal.

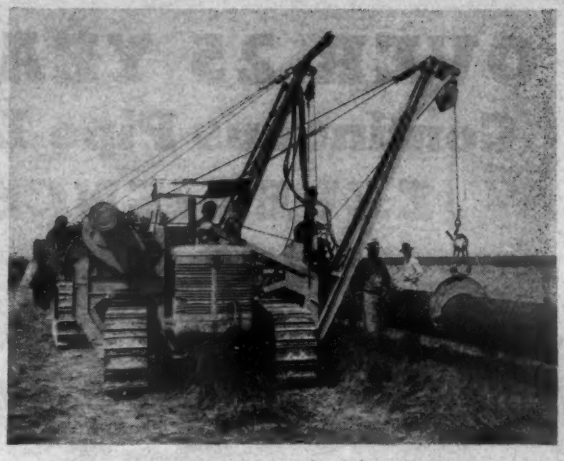
A winch and boom, mounted on a truck was utilized to effect the crossing. This operation, viewed in Fig. 2, shows how the pipe was made to bridge the canal by fastening a rope to one end which passed through an anchored winch on the opposite side of the crossing (foreground) then back to the boom and winch of the truck.

A review of some of the nation's principal pipe-line construction jobs shows that today the stove-pipe method was widely used in rough, mountainous country and roll welding was generally used over flat or fairly smooth terrain.

Where both conditions were encountered, contractors found that greater efficiency could be effected by using a combination of stove pipe and roll welding.

Fig. 1 (left): Stovepipe welding on recent emergency oil-line project. Note alignment fixture to facilitate tacking of joints. Fig. 2 (right): Truck hoist swinging welded lengths over water crossing. Cable line, anchored at near side of canal, was fastened to one end of pipe and sections were drawn across by reeling in cable on truck





Left: A 24-in. weld in the process of being made by pressure-weld machine. Right: Line-up tractor working with pressure-weld tractor in lining up joint prior to welding

Pressure Welding Applications Increase

by A. L. Forbes, Jr.*

PRESSURE welding has been employed for approximately 310 miles of 24-in. pipe line for Tennessee Gas & Transmission Co. for the portion of the line extending from the gas fields near Agua Dulce, Tex., to a point approximately 30 miles east of the Trinity River, all in Texas.

The welding was subcontracted from three contractors operating as follows: Williams Brothers Corp., one crew, 117 miles; N. A. Saigh, two crews, 120 miles; and Brown, Root & Whitaker, one crew, 67 miles.

The fastest time made on the project was in the welding of a mile on the Williams Brothers spread in 7 hours and 25 minutes. The entire welding on this spread in Section 1 was completed September 2. The record was as follows: Average of 136 welds per day at the rate of 1.3 miles per day of elapsed time; average of 156 welds per working day, an average rate of 1.18 miles per day.

In Section 2, N. A. Saigh completed work of its first welding gang August 23 with a record showing an average of 132 welds per day at the rate of 1 mile per day elapsed time; and 142 welds per day at the rate of 1.08 miles per average working day. Saigh's second gang completed welding on August 19 with a record of 86 welds per day elapsed time at the rate of 0.66 mile per day; 93 welds per day at the rate of 0.71 mile per working day.

In Section 3, Brown, Root & Whitaker laid pipe over country with numerous hills and creeks which impeded progress. Near the close of the work the record showed 82½ welds per day at the rate of 0.63 mile per day elapsed time and 94½ welds per day at the rate of 0.72 mile per working day.

The weather was extremely hot throughout the progress of these jobs and it has been found that, in order to expedite progress, it was advantageous to work a double shift. This permits from 14 to 15 hours of welding per day and it has been found that the lineup and welding crews are much more efficient during the 7 or 8-hour day than if a 10 to 12-hour work day was worked for 7 days during the week. A high daily output on this section, where two crews were working, was 210 24-in. welds or 8,400 ft. of line welded in 1 day.

The lineup and welding crew and equipment used in pressure welding a pipe line consists of two men and a team-drawn wagon which carries a 1,500-watt electric generator for grinding ends of pipe and carries other supplies for such crew. The actual lineup crew consists of a lineup tractor, tractor operator and swamper, one man steering pipe, two skid men, two jack-board men and one general helper. The actual pressure-weld crew consists of a pressure-weld tractor and operator, two pressure-weld-machine operators and one man to do miscellaneous work around the equipment such as changing oxygen cylinders and assisting in recharging the acetylene generators. The remainder of the crew is made up of the usual skid trucks and swampers and a water truck for filling the acetylene generators. With such equipment in good level country, a mile of welding per day has been easily attained. Shutdowns due to repairs to pressure-weld equipment have been few and of short duration. However, in several instances it has been necessary to put additional men ahead of the grinding crew to straighten out badly damaged pipe

Patented equipment used in cleaning up ends of joint prior to welding

*President, Pressure Weld Co.

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joints, such damage having been incurred en route or in unloading and stringing on the right-of-way.

Considerable progress has been made by Pressure Weld Co. during this job in making this method of welding more automatic. As an example, equipment has been designed and added which provides a uniform width of heat band on either side of the two joints to be welded and means have been provided to secure a uniform amount of upset on each joint. An automatic method of accomplishing both of the above results is now being developed.

Another improvement being made is a method of straightening bad ends of pipe ahead of the grinding crew which, when perfected, will speed up the work considerably and assist generally in the welding process, as well as expedite the training of operators for the pressure-weld machinery. Since the start of pressure welding on the Tennessee Gas & Transmission Co. line, 14 new pressure-weld operators have been trained and it is hoped soon to start a school for the purpose of training men to operate such machines.

Underground Cable Provides Communication

(Continued from page 243)

an additional furrow or small ditch will be dug simultaneously with and in the center of the pipe-line ditch. This furrow should be about 2 in. wide and 3 in. deep. This would allow the installation of the cable just ahead of the pipe line and prevent the pipe line from laying directly on it.

Where streams of considerable size are crossed, submarine cable should be substituted for the land cable.

Underground cable for communications is by no means new as it has been in use by the telephone and telegraph companies for many years, but its adaptation for use by pipe-line companies has not been attempted. However, many communications engineers in the pipe-line industry have given a great deal of thought and study to the idea and this discussion is being given in the hope that it will inspire those who are interested in the further development of this type of communications. It is hoped that other communications engineers will give this idea some further study and help bring it nearer perfection.

Special acknowledgment should be given to E. C. Bertnolli of Great Lakes Pipe Line Co. for the great amount of time and effort which he has contributed, over a period of several years, toward the development of underground communications systems for pipe lines.

Priming machine operating on N. A. Saigh Co. spread north of Houston

New Construction Methods Developed

(Continued from page 151)

sippi, Arkansas, and Louisiana. This was in the last half of August when this contractor was approaching completion of the work of five spreads which laid a total of 375 miles. Conspicuous features of this firm for increasing the speed of its operations under difficult conditions were the warehouses with large stocks of parts and shop facilities for maintaining equipment, the measures taken for the rebuilding of ditching machines to attain greater efficiency, and items of the equipment added to the type of cold-bending machine which it has adopted and developed for it own work.

Shop Operations

The ample shop of the firm at Dixville, Tenn., provided for operations by lathe, key seater, drill press and trip hammer (for work on ditcher cutters). Gears are pressed in by using a pipe straightener as a hydraulic press. Because of the lack of housing in the sparsely settled country around Lobellville, Tenn., it was necessary for Williams Brothers Corp. to establish a camp there to accommodate the men of the spread.

To speed up ditching, the firm has revamped ditchers at its Houston shops. This has been done by substituting 150-hp. diesel engines for 100-hp. gasoline engines; installation of a clutch makes it possible to conveniently and quickly change the speed of the wheel thus eliminating the need for changing a chain to a sprocket of a different size. This is in accordance with improved design of modern ditchers not yet generally available for civilian use. In rebuilding ditchers, frames have been made stronger and lengthened.

Rooters have been used in some cases ahead of the ditcher by Williams Brothers but its principal employment has been in right-of-way work.

Two-stage ditching has been done by a number of contractors on the Tennessee line. For digging a ditch 40 in. wide and 5 ft. deep, two-stage ditching is accomplished by having either a light or a heavy ditcher cut a ditch 24 in. to 30 in. wide and 30 in. deep ahead of a heavy ditcher compieting the ditch to its final depth and width. By two-stage ditching work has been done more rapidly with elimination of much "roading."

Throughout the laying of the line, stove piping has been generally used by all contractors over all types of terrain with the exception of swamps where it was advisable to pull pipe across in fairly long sections. The wide acceptance of stove piping appears to have come as the result of analyses of costs of pipe lining under varied conditions in the last few years.

A modification of stove piping has been used by Midwestern Engineers in Louisiana where pipe is double jointed so that it may be handled in 80-ft. instead of 40-ft. lengths in the stove-pipe procedure. In lining up pipe, this firm has utilized a conventional type of outside welding clamp in the crossbars of which two threaded holes have been bored, each on opposite sides of the clamp. When it is desirable to apply pressure this is accomplished by turning a threaded bolt by means of a rachet wrench. For a considerable extent of this firm's section, operations were impeded by slow ditching where there were many roots and stumps. Where the ground was favorable work progressed at a good rate.

Among the revolutionary innovations in big-inch pipe lining of the last 2 years probably the greatest amount of attention has been directed to the cold-bending machine method, the value of which was first demonstrated to the industry by equipment of Crutcher-Rolfs-Cummings, utilized in laying the War Emergency Pipelines, Inc., lines last year. Cold bending by the machine method has been employed throughout the length of the Tennessee line. This procedure was regarded as being so essential for the satisfactory bending of large-diameter, thin-wall pipe that it was specified for all spreads. The procedure followed is to have an engineer mark the joint to be bent at each point where a wrinkle is to be made. The amount of bending at each wrinkle is 1½ to 2° or 3°. Wrinkles are commonly 3 ft. apart. As many as eight or

Construction camp of Williams Brothers Corp. in wilderness near Lobellville, Tenn.

nine wrinkles have been put on one 40-ft. joint but a total bend of 15° is generally regarded as the practicable maximum to avoid buckling. In ravines between two steep hills, where the bend is so sharp that there is less than a joint's length between the two slopes, construction men have employed factory bends from the limited stock which had to be used sparingly. In a few cases some sweeping bends were made in sections of pipe without using the machines.

Cold-Bending Development

In addition to Crutcher-Rolfs-Cummings equipment, cold-bending machines have been developed by J. R. Horrigan Construction Co., and Williams Brothers Corp., primarily for their own use. All types of cold-bending machines are mounted on heavy sleds, towed by tractors. A shoe flexes with the pipe during bending while a clevis holds one end rigidly. Each of these machines is commonly equipped with a 40-hp. gasoline engine which operates a winch for bending. The original method was to bend by tractor power. In some cases an additional winch is installed for "endoing." One type of machine has equipment inserted within the pipe to prevent buckling; another type has provision for hydraulic equipment to function in the forming of a wrinkle. A slot in the device holding the pipe has been cut out to allow the wrinkle to protrude through it. Effectiveness of operations has been increased by installation of a davit or crane to hold blocks or pulleys in a position so that a straight pull on the pipe can be obtained.

Lining up near Many, La., by Ray L. Smith Construction Co.

The adoption of pressure welding for all of the 310 miles of 24-in. for the Tennessee line in Texas was the result of convincing evidence that pipe-line welding could be done faster and cheaper by this procedure which forms a blacksmith's weld by the application of heat, from oxy-acetylene flames and hydraulic pressure. The results obtained and improvements being sought in the pressure-welding procedure are described elsewhere in this issue.

East of Texas the Tennessee line was welded by conventional arc-welding methods. Ends of the pipe are spaced about 2/100-in. preparatory to welding. The stringer bead is made with a 5/32-in. electrode; the two beads which follow with 3/16-in. electrodes.

There is a widespread practice to support pipe on skids placed 6 ft. or more from the ditch. This arrangement has the advantage of permitting ditching and other operations to be carried on without impeding

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each other. Skids are piled sufficiently high to support the pipe at a height from the ground to provide easy access for welding operations. In some mountain areas welding was observed being carried on where pipe was supported on skids across the ditch.

Contractors have operated coating and wrapping equipment in accordance with specifications in sections for which pipe protection was designated.

In the boring of certain railroad crossings the power-driven equipment originally developed by Loy Wilson was used by Bechtel-Dempsey-Price.

For moving welding equipment along the right-of-way much use has been made by several contractors of a substantial type of low sled fabricated of welded pipe which cannot easily be overturned. Comment is varied among construction men regarding the value of the military vehicle known as the jeep when

Lowering in by Bechtel-Dempsey-Price on Kentucky mountainside

utilized in connection with pipe lining. Reconditioned ex-Army jeeps have been available. Because of their versatility it was said that there has been a temptation to drivers to push them beyond the limits of performance for which they were designed.

Because of the large amount of difficult terrain traversed by the Tennessee line much attention had to be given to expediting ditching operations in order to permit continuous progress of other operations.

The new methods on the Tennessee line reflect the advance of certain phases of pipe lining since the beginning of the WEP 24-in. crude-oil line 2 years ago when standard methods were used. In the laying of the WEP lines, initiative has been stimulated to devise new procedures and revamp old ones. It is noteworthy that within 2 years stove piping has gone from being a practice of questionable value for big-inch pipe to being generally accepted as the most economical method for laying pipe over most terrain, except that of extensive dry, flat country. As a result of the WEP program much heavy equipment, desirable for big-inch construction, became available. Procedures have been developed through the resourcefulness of contractors and equipment men in order to improve construction efficiency.

M. R. Spahr, geologist for The Carter Oil Co., has been transferred from Tulsa to Carmi, Ill.

George H. Loch, chief scout for Shell Oil Co., Inc., in the Illinois basin area, has been transferred from Centralia to Baltimore. **Mickey McMullen,** formerly at Evansville, Ind., succeeds him at Centralia.

C. H. Conway is in charge of an office which Amerada Petroleum Corp. has opened in Jackson, Miss.

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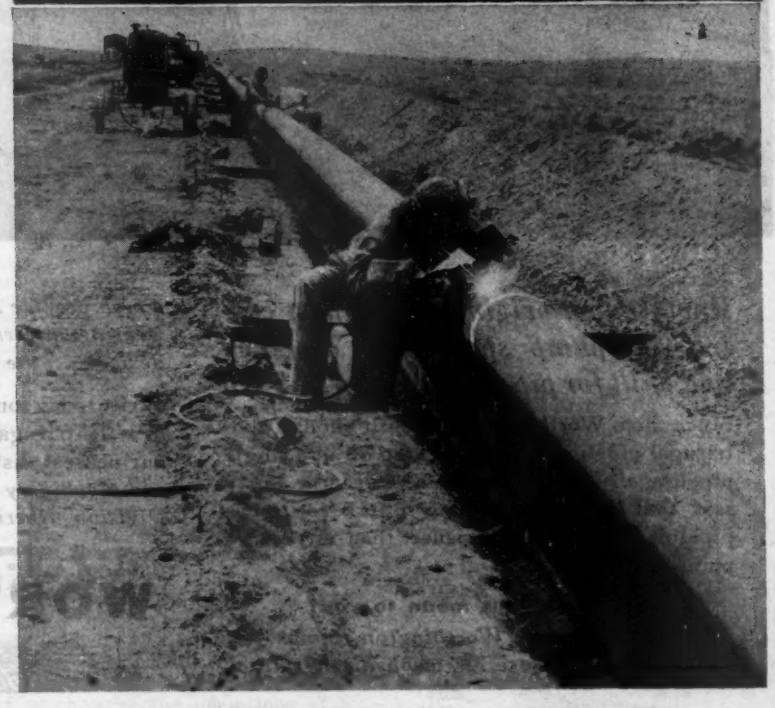

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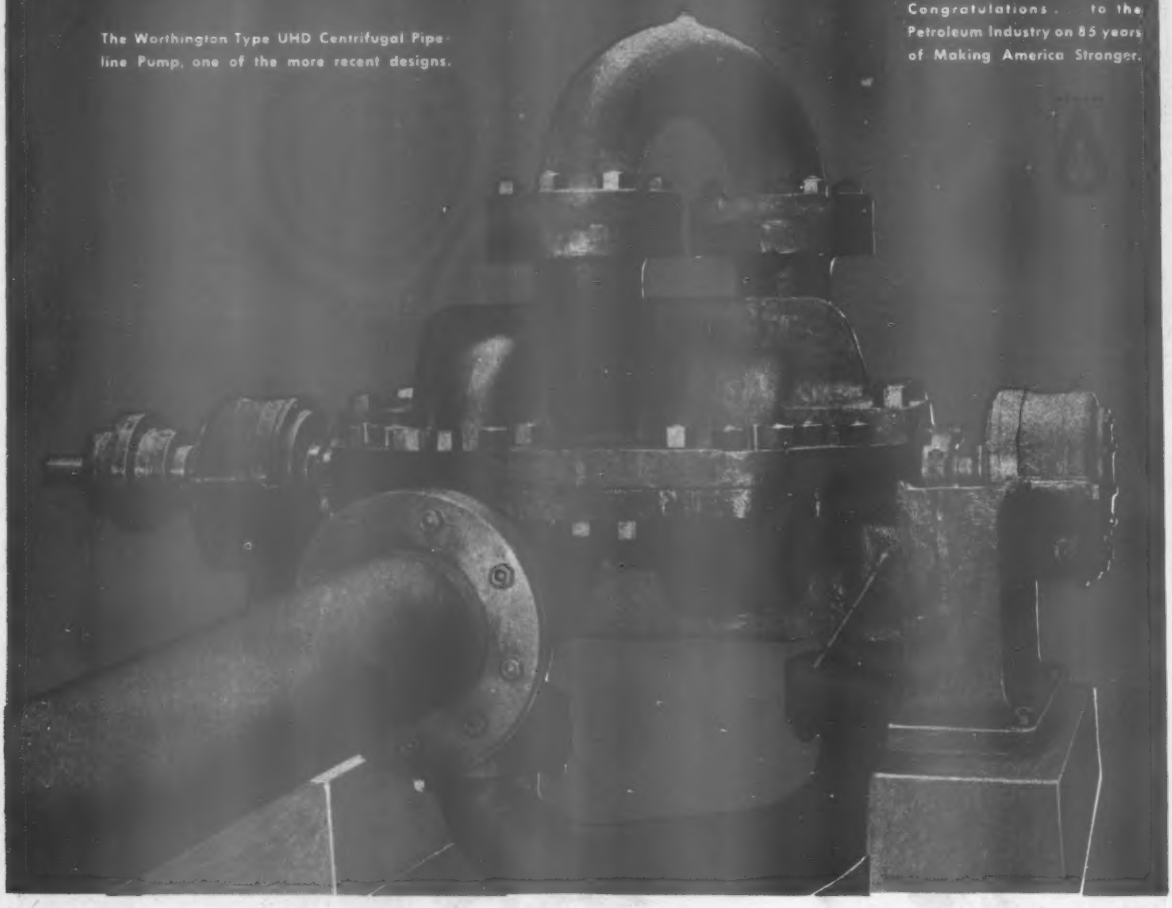

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Trend in Pipe Line Practices

(Continued from page 155)

such lines) can be pooled for transportation. However, the 20-in. and 24-in. lines of the War Emergency Pipelines, the 16-in. trunk line of Stanolind Pipe Line Co. out of West Texas, and the 16-in. line built by Gulf in Venezuela several years ago foretell the use of larger-diameter pipe in the future. For new long trunk lines, and possibly for modernizing some of the older multiple-line systems, sizes of pipe from 12 in. to 16 in. will predominate. And, as stated previously, there will be larger lines when conditions warrant them. Sizes of pipe below 12 in. in diameter are not, in general, suitable or economical for long trunk lines. Pipe smaller than 12 in. will be used principally for tributary lines. Through the use of larger-diameter pipe, using fewer pumping stations, the investment in a larger line may be considerably less than that of a smaller line requiring a greater number of stations. Other advantages of the larger lines are: (a) operating costs are reduced; (b) by greater spacing between relay stations, the capacity of the system can be materially increased by building intermediate stations at economical distances between them, if and when required, and (c) greater flexibility in operations can be realized. In discussing this important development in the industry, due credit should be given to the executives and engineers who decided on the use of 20-in. and 24-in. pipe, and formulated and executed the plan for the War Emergency lines between East Texas and the Atlantic Coast. Indeed, it was a courageous decision that has proved sound. The author does not believe there was ever any doubt about the hydraulic design, but without any previous experience in the operation of long lines larger than 16 in. in diameter, any doubt about unforeseen operating problems was justified. The success of the big-inch, 1,363 miles in length, is found in the fact that it transported in the past 12 months 96,292,000 bbl. from Longview, Tex., to the Atlantic Seaboard. The daily average for this period was 263,000 bbl. In a recent month the daily average was 314,134 bbl. The highest daily throughput was 326,332 bbl. It is understood that the little big-inch has been an equal success in transporting petroleum products. Appropriately, reference should be made to the fact that this project became a reality and its success is due in a large measure to the sponsorship and firm support of Secretary of the Interior Harold L. Ickes, who deserves much credit for recognizing the need of it and seeing it through the formative planning.

The use of 20 in. and 24 in. in the War Emergency project has in a single stride covered a stretch of progress that might have occurred slowly, in short successive steps. From this and other recent projects, the pipe-line engineer has learned a lesson in the advantageous use and the practicability of large-diameter, long-distance crude oil lines. It should be mentioned, also, that the actual pumpings through the 24-in. line confirm the rational formulas used by pipe-line engineers for the design of pipe lines. It is understood that the coefficient of friction for the friction loss in this 24-in. line conforms nearly with the Stanton and Pannell curve for smooth pipe. Although anticipated, this information adds faith in the rational formulas that have been used for the design of crude-oil pipe lines during the past 20 years.

Less Storage and Fewer Working Tanks

Another outstanding feature of the War Emergency designs, and I believe this is true also of the Plantation Pipe Line, is that no tanks are provided at any of the relay stations on the entire line, excepting junction points. It is presumed that this was done in the case of the War Emergency lines to conserve steel, to simplify the stations, and to expedite the completion, and because the useful life of the line could not be predicted. The trend has been toward the elimination of, or reduction in capacity of, storage tanks at relay stations on newly designed systems. The author believes that tanks can be eliminated at some of the relay stations, but not at all of them, on a long line. It is difficult to synchronize the operations of a series of stations without providing tanks at some of the stations to take care of surges and variations in the rate of pumping, especially when a line is operated at its capacity. And a higher over-all capacity of a line can be maintained by having some storage tanks along the line. It remains to be determined definitely that long pipe lines, hundreds of miles in length, can be operated satisfactorily over a period of years without storage tanks at the intermediate stations.

Modern Designs Use Higher Tensile Steel

In adopting higher-tensile-strength steel and higher working stresses in the design of modern pipe lines, the pipe-line engineer is striving for the most efficient use of the steel. This has led to higher operating pressures, larger diameters, and less wall thickness and weight, all of which will be discussed subsequently. The ultimate tensile strength of the steel used in these designs will average from 70,000 to 75,000 p.s.i. and the average yield will range from 46,000 p.s.i. for seamless pipe to 55,000 p.s.i. for some electrically welded pipe. The working stresses used in modern designs may vary from 18,000 to 24,000 p.s.i. The trend is to the higher figure. It seems reasonable to use a working stress up to about one-half the yield. In case of an emergency, even higher working stresses can be justified. Typical physical and chemical characteristics of this grade of steel are shown in the tables below:

PHYSICAL AND CHEMICAL PROPERTIES OF STEEL IN ELECTRICALLY WELDED PIPE

	Average	Range
Carbon	.253%	.20%-.32%
Manganese	.719%	.57%-.86%
Ultimate strength p.s.i.		
Longitudinal	76,150	68,800-83,900
Tranverse	76,930	71,000-85,500
Yield point (0.5% stretch) p.s.i.		
Longitudinal	53,700	48,600-60,400
Transverse	57,220	50,000-65,800
Elongation in 2"		
(Longitudinal specimen only)	35.2%	29%-41%

PHYSICAL AND CHEMICAL PROPERTIES OF STEEL IN SEAMLESS PIPE

	Average	Range
Carbon	.26%	.19%-.30%
Manganese	.68%	.35%-.95%
Phosphorus	.012%	.007%-.018%
Sulfur	.022%	.016%-.035%
Ultimate strength p.s.i.	71,000	57,500-79,400
Yield point p.s.i.	46,000	36,400-60,000
Elongation in 2"	35%	31.0%-41.0%

Thinner Walls for Pipe

For many years only standard-weight pipe was used in the oil-pipe-line industry because a certain minimum wall thickness was required for threading. At this point it may be of interest to show the standard weights for sizes of pipe customarily used in the past for crude-oil trunk lines:

Size, inches, o.d.	Pounds per foot
6.625	18.97
8.625	28.55
10.75	40.48
12.75	49.56

The advent of welding made possible the rational designing of pipe lines, using no more wall thickness than required for the operating pressures. This has resulted eventually

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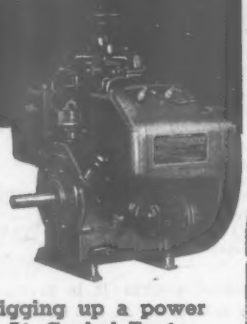

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in a more efficient use of the steel. And as explained previously, the adoption of stronger steel, which came with seamless and electrically welded pipe, paved the way for thinner walls. A few companies used some of the thinner-wall pipe (bell-and-spigot or double-bell-and-chill-ring joints) in the first welded lines. But the bell-and-spigot and double-bell-and-chill-ring joints became obsolete soon after their first use, because the welded butt joint was regarded as the most practicable. Notwithstanding the benefits and economies in the thinner walls, many companies continued the use of standard weight pipe through the years of transition required for the developing fully of the art of welding pipe lines. And a few companies still use the standard weights on the assumption that the thicker walls can be justified by laying lines bare, thereby saving the cost of the coating and on the claim that the life of the bare line will be as long as the coated line. The author does not believe that this is true.

Good engineering does not sanction the use of more steel in pipe lines than required for safe operations. And under new economic conditions; referred to in the first part of this article, thrift must be observed in the design of future pipeline systems. What weights of pipe and wall thickness can be expected? They should be determined by the hydraulic pressure gradient of any section of a line, using steel having properties similar to those shown above and working the steel at a stress not to exceed one-half of the yielding strength of the steel. The author believes that pumping pressures in the future will be nearer 1,200 p.s.i. than the usual 750 p.s.i. It is the author's opinion that for sizes of pipe above 8 in., the wall thickness may vary from 0.25 in. to 0.50 in., possibly some 8-in. having less than 0.25 in. wall will be used. During the past year, substantial amounts of 0.25-in. wall seamless and electric-welded pipe have been used in a long 16-in. trunk line, and it has proved thoroughly satisfactory. The new bending machine, adopted generally by contractors, makes it possible to bend the 0.25-in. wall pipe without buckling and "egging." It has been learned by experience that a 37.5° bevel is required for the 0.25-in. wall pipe. The thinner-wall pipe in the larger diameters is more difficult to line up for welding, but this problem will be solved. Even for the higher operating pressures, a large percentage of a line can be constructed of 0.25-in. wall pipe, and for this reason the author believes that a large quantity of 0.25-in. wall pipe will be used in the future. In the larger diameters, 10-in. and above, 0.25-in. appears now for practical reasons to be the minimum wall thickness that will be used.

The following table shows an interesting comparison between the weights of various sizes of pipe for 0.25-in. wall and the standard wall thickness that has been used for years:

O.D. (in.)	Wall thickness (in.)	Weight, pounds per ft.	Wall thickness (in.)	Weight, pounds per ft.
8⅝	.250	22.36	.322	28.55
10¾	.250	28.04	.365	40.48
12¾	.250	33.38	.375	49.56
14	.250	36.71	.375	54.57
16	.250	42.05	.375	62.58

It is noteworthy that 0.25-in. wall 16-in. (15.5-in. i.d.) weighs 7.51 lb. per ft. less than the 0.375-in. wall 12¾-in. (12.0-in. i.d.) and that 0.25-in. wall 14-in. (13.5-in. i.d.) weighs 3.75 lb. per ft. less than the 0.365-in. wall 10¾-in. (10.054-in. i.d.). In the comparison of the 12¾-in. (49.56 lb. per ft.) and the 16-in. (42.05 lb. per ft.), it should be mentioned that the 16-in. would have twice the capacity of the 12¾-in. for the same pressure drop per mile. It is believed that by now many companies specify less than standard weight for 12¾-in., possibly 45.55 or 37.45 lb. per ft.; however, in the case of the 8⅝-in. and 10¾-in., the standard weights probably continue to prevail. The purpose of presenting this comparison is to support the previous discussion concerning the trend to larger diameters and to demonstrate the economies of using the higher strength steel and weights that are determined by hydraulic pressure gradient and a safe working stress, which the author believes for everyday practice can be up to one-half the yield point of the steel. For pipe having the properties shown above, the author believes a working stress of 21,000 to 22,000 p.s.i. is reasonable and safe. As a sequel to the trend to thinner walls, another important change in the design of pipe lines is occurring.

Use of Various Weights of Pipe in the Same Section

New pipe lines are designed to use various weights of pipe. Screw pipe requiring a certain weight of pipe for a safe threaded joint, was laid in the earlier days, using the same weight of pipe (necessarily so by the nature of the joint), throughout the entire line. This practice has continued as a vestige for years after the screw joint was discarded. This old practice of using the same weight of pipe from the beginning to the end of a line is giving way to a rational design of using whatever weight of pipe is required to meet the hydraulic pressure gradient. Now, good designs specify several weights of pipe in a section of line between pumping stations. Logically, the same weight of pipe used for the high-pressure end of a line should not be used for the intermediate and low-pressure sections, unless the minimum weight to be used is suitable for the entire line. This assumes that the reader understands that in mountainous terrain, the weight of the pipe must be based on the hydraulic pressure gradient. The number of different weights of pipe that might be used depends on such factors as the minimum weight that a company is willing to use, the operating stations, the diameter of the pipe, plans for intermediate pumping stations at a later date, and the terrain over which a line is to be laid. In Stanolind's Slaughter-Drumright 16-in. line, 385 miles in length, three weights of pipe were used: 351 miles of 0.25-in. wall (42.05 lb. per ft.), 30 miles of 0.284-in. (47.66 lb. per ft.) and approximately 4 miles of 0.50-in. (82.77 lb. per ft.) for river crossings. This line was designed for 700 to 800-lb. pumping pressures. All of the pipe was tested to 1,100-lb. pressure. On this line, the 0.25-in. (wall) pipe represented 91 per cent of the total. The 30 miles of 0.284-in. (wall) pipe was used in two 15-mile sections, out from the two pumping stations on this line. For its Elk Basin-Casper (Wyoming) 12¾-in. line, Stanolind is using four weights of pipe, due to the mountainous terrain: 99 miles of 0.25-in., 54 miles of 0.3125-in., 84 miles of 0.375-in. and 0.57 miles of 0.5-in. for river crossings. This line is designed for pumping pressures up to 1,500 p.s.i., using two pumping stations at the beginning. For 41.48 miles of 16-in. high-pressure loops being laid in its main line between Drumright, Okla., and Sycamore, Kans., for increasing its capacity and at the same time replacing 6-in. and 8-in. screw-joint lines, the same company will use 18.5 miles of 0.2812-in. (wall), 16.1 miles of 0.3125-in., 6.6 miles of 0.3437-in., and 0.28 mile of 0.5-in. for river crossings. The heavier pipe is provided in these loops for 1,000 p.s.i. pumping pressures.

Light-Weight Pipe for Gathering Lines

For field gathering systems, there is also a tendency to the use of considerably less weight in the 4½-in. and 6⅝-in., which are prevailing sizes for field gathering systems and tributary lines. This is resulting from the same fact that the screw joint is also giving way gradually to either a welded or a gasketed coupling, and the latter is likely to take the lead for gathering systems. A large amount of 7.64-lb. 4½-in. plain-end seamless, replacing 10.79-lb. screw-joint pipe, has been purchased and used by one major company during the past 6 or 7 years. This pipe, in 40-ft. lengths, requires welding. After the war a gasketed coupling will probably replace this

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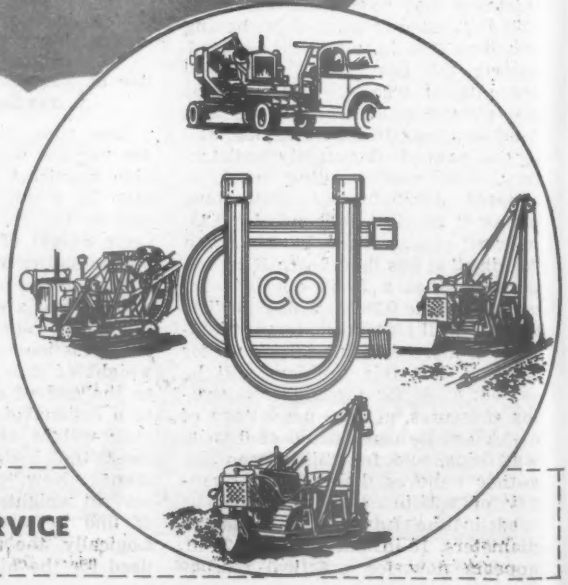

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welding. Four-inch pipe, weighing 4.5 lb. per ft., and 6-in., weighing about 9 lb. per ft., will find an extensive application in the pipe-line industry after the war. Already one major company is using large quantities of the 4.5-lb. 4-in. The 7.64-lb. and the 4.5-lb. 4-in. may reduce considerably the use of standard-weight thread and coupling 2-in. and 3-in. pipe.

Higher Operating Pressures

New pipe lines are designed for higher pressures. Operating pressures of 1,000 to 1,200 p.s.i. will become common practice, using either reciprocating or centrifugal pumps. A customary practice of the industry, due to the limited strength in the pumps and piping systems, has been to operate at pressures around 750 p.s.i. Some engineers oppose the use of higher pressures because they believe the lower pressures are more economical. But they are thinking principally of the velocity factor (V^2) in the friction loss. The author recognizes the economical limitations with respect to the higher velocities. But the higher pressure may be applied for other purposes. It can be used advantageously for: (a) greater spacing between pump stations, (b) fewer pump stations, (c) flexibility in increasing capacity of the system at a later date, (d) carrying temporary peak loads, (e) maintaining the capacity of the system through the cold months when the oil is cold and the friction losses are higher, (f) transporting heavy viscous crudes, (g) retrieving shutdown time by operating at higher capacity and pressure, (h) maintaining line capacities in batching crude oils having a wide range of viscosities, (i) flexibility in spacing stations in difficult terrain, and (j) meeting high-pressure operations in mountainous regions. These advantages have been well demonstrated in the 8-in. line of Utah Oil Refining Co. between Fort Laramie, Wyo., and Salt Lake City, Utah, which crosses the Continental Divide. The most apparent result of the higher operating pressures is greater distances between pumping stations.

Fewer Pumping Stations

New pipe lines are designed for fewer pumping stations. For economical reasons, as few as possible are provided. It has been learned that it is better to invest in larger-diameter pipe and higher-pressure equipment than in numerous pump stations. If the first cost is not less from the very beginning, the greater cost of the larger-diameter line is paid out by the difference in the operating expense within a few years. The original planning and designing provide for the ultimate estimated number of stations required in growth of business. Part of them are installed at first and the intermediate stations are built as needed. The space between the original stations and the design of the lines are made to conform with this scheme. Like other practices, associated with lapweld screw-joint pipe lines, the spacing of stations has been carried over as a vestige and still influences the thinking of pipe-line engineers. There was good reason for a lack of faith in and apprehension over the old screw-joint, lapweld pipe line of earlier days. This doubt and fear in the minds of pipe-line engineers and management coupled with the limitation on operating pressures, prevented for years greater spacing between stations. All of this should have vanished with the adoption of the modern welded line. Gradually, the new practice is being adopted. It is the economical thing to do in most cases. Spacings of 50, 60, and 70 miles between pumping stations are common, even up to 100 miles. In a few exceptional cases, the pumping distances are over 200 miles. The author is able to mention some concerning which he has first-hand information. On Stanolind Pipe Line's 385-mile 16-in. from Slaughter field, Texas, to Drumright, Okla. (a downhill pump all the way, but with most of the fall in the half toward the initial station), there are only two stations, an initial and an

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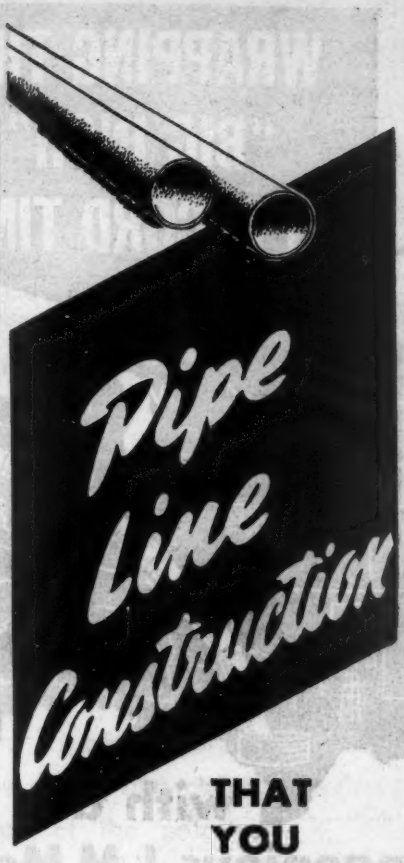

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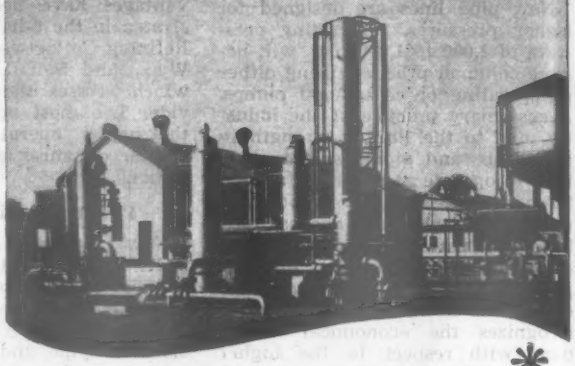

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intermediate station. The distance from the initial to the intermediate station is 224 miles, and between the intermediate station and the junction with the trunk line at Drumright, the distance is 161 miles. The pumping pressures on this line are 700 to 800 p.s.i. and the maximum capacity in the summer months is 72,000 bbl. per day. The line is designed for higher capacities by adding intermediate stations later. On Utah Oil Refining Co.'s 8-in. line from Fort Laramie, Wyo., to Salt Lake City, Utah, crossing the Continental Divide, the pumping distances range from 100 to 200 miles. At maximum capacity, the pumping distances range from 100 to 140 miles. The maximum operating pressure on this line is 1,650 lb. at one station, pumping a distance of 100 miles over a 3,000-ft. rise in elevation. Stanolind's Wyoming division from Welch, Wyo., to Freeman, Mo., is a screw-joint, lapweld 10-in. and 12-in. line built in 1922 and 1923. It is a downhill pump all the way from Glendo, Wyo. Notwithstanding the fact that it is an old-style line, over 21 years old, long-distance pumping is practiced very successfully. On this 675 miles of line, rehabilitated in 1936, there are only five pumping stations, spaced successively, beginning at the west end, 79, 218, 217, 84, and 76 miles apart. The operating pressures are about 750 p.s.i. The capacity from Welch, Wyo., to Washington, Kans., is 22,000 bbl. and about 55,000 bbl. for the east end from Washington, Kans., to Freeman, Mo. Orifice and displacement meters are used advantageously for operating this line safely. Another example is a pumping distance of 145 miles through an old screw-joint 8-in. line from Ranger, Tex., to Healdton, Okla. Part of this information has been related in some of the author's previous articles; however, its repetition may have some value in bringing up to date the general subject of fewer pumping stations and greater pumping distances.

Reserve Factor in Designs

New pipe lines will be designed for a reserve capacity. Too often in the past, pipe lines have been designed without reserve capacity in the line and the pumping equipment. A higher-pressure system, having spare capacity through potential reserve strength in the pipe, valves, fittings, and pumps, can be built for a reasonable additional first cost. By a higher-pressure system, the author means a system designed for 1,000 to 1,200 lb., or even higher under certain conditions, compared with the conventional 700 to 800 p.s.i. operating pressures. The difference in the cost is found in stronger fittings and valves in the discharge lines and manifold piping

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at the pumping station, in heavier pipe on the high-pressure section of the line, and in the high-pressure pumps. The reserve pumping capacity may be obtained by a spare unit installed originally, or at a later date. In the case of engine-driven equipment, reserve horsepower can be obtained to a large extent by higher speeds and supercharging. A few hundred dollars spent in larger electrical motors is justifiable. Reserve capacity in pumps should be provided for also in the specifications.

This reserve factor in designs is very useful for: (a) meeting peak loads, (b) maintaining the capacity of a system throughout the year, (c) providing for "growth" of traffic, (d) handling more viscous crudes than planned for originally, and, (e) meeting unforeseen conditions affecting the operations of a line. It is a well-known fact that the capacities of most pipe lines are reduced during the winter months when the crude oils are most viscous. For example, on a large Mid-Continent pipe-line system, operating at a limit of 750 p.s.i., the range of capacity from its nadir in the winter to its zenith in midsummer, is 11 per cent of the annual average. In terms of pressure, the annual average capacity would require 675 p.s.i. in summer and 850 p.s.i. in the winter. On many of the older systems, the pressure limitation is 750 lb., either on account of safety factors or insufficient horsepower. Consequently, the winter capacity is limited by that factor. In other words, the summer and the average capacities cannot be maintained through the winter months. This range in capacities and pressures from summer to winter is still greater in colder regions, such as the Rocky Mountain area, and when more viscous crudes (than the average Mid-Continent crudes) are transported. In the case of the 11 per cent range in capacity from winter to summer, there is a corresponding range in horsepower requirements, the greatest amount being required for the maximum capacity in the summer and the least amount for the minimum capacity in the winter. A very good example of such conditions is the high-pressure 8-in. line of Utah Oil Refining Co. from Fort Laramie, Wyo., to Salt Lake City, Utah. This line operates under unusual conditions. Aside from the fact that various types of crudes, requiring batching, are transported, the temperature of the crude in the line goes as low as 28° F. in the winter and some of the crudes are very viscous at the low temperatures. Notwithstanding these operating difficulties, this line has functioned smoothly the year around, due principally to the "pressure reserve" which was always available.

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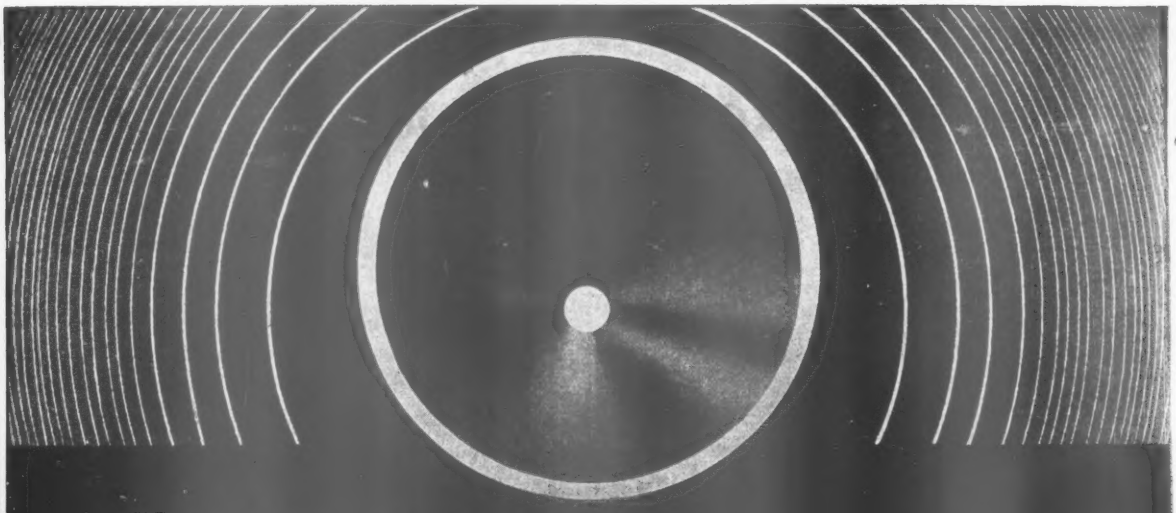

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SHELL

Control of High-Pressure Salt Water and Heaving Shale in Deep Gulf Coast Well

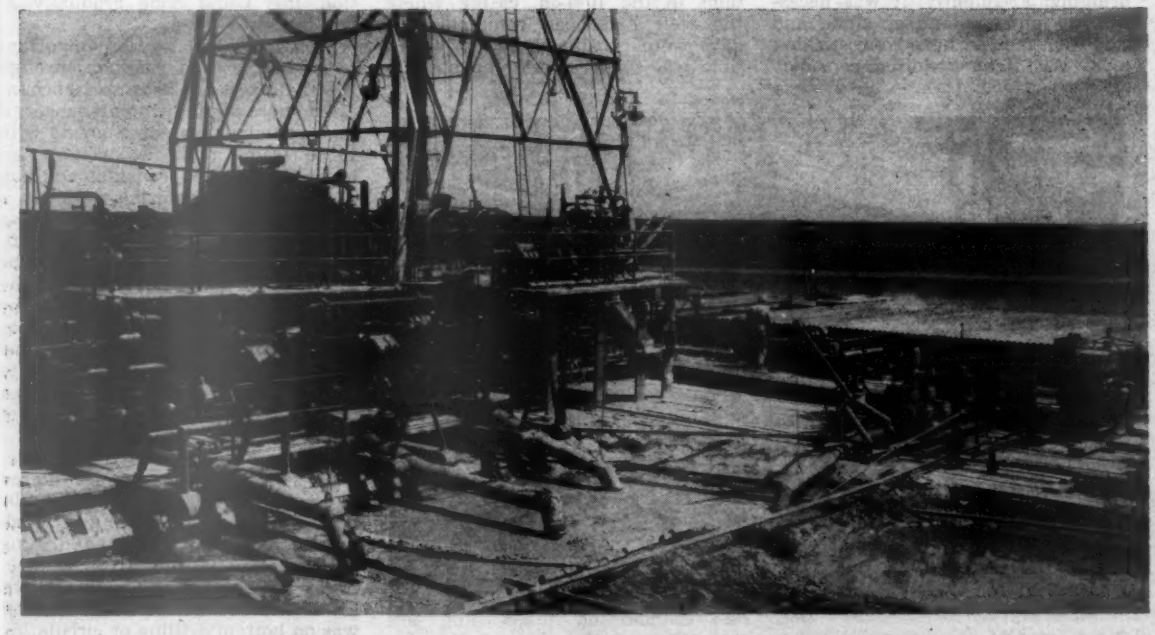
by Neil Williams

Heaving shale, abnormal gas pressures and hot-salt-water flows constitute major obstacles to deep drilling in many areas on the Gulf Coast. The combination of the three hazards in a single well present complications that are exceptionally difficult to combat. The successful overcoming of these conditions in the deep test discussed in this article represents an unusual achievement. Special precautions to insure close control of the mud treatment and safeguard the well were necessitated.

HEAVING shale and high-pressure, hot-salt-water flows, which long have been obstacles to deep drilling in many areas on the Gulf Coast, were successfully overcome by Glenn H. McCarthy, Inc., in McCarthy and Phillips Petroleum Co. 1 Maco Stewart, deep test recently completed in the Hitchcock field, Galveston County, Texas. Conditions under which the well was drilled presented a number of unusual problems, both mechanical and in mud control. Special precautions were necessitated and practices followed to insure the safety and final completion of the hole.

The well was drilled to 12,588 ft. The bad shale section was topped a little above 7,700 ft., and continued to bottom, a total of more than 4,890 ft. Predominately shales, which sloughed and caved easily, the section also contained a number of sand and sandy shale zones carrying abnormally high pressures. Strong salt-water flows were encountered at various levels below 9,400 ft. Control of these flows required an extremely delicate balance of mud weight and pump pressures to prevent loss of fluid into the formations.

Open hole maintained below the last protection casing, set at approximately 8,200 ft., a little over 500 ft. below the top of the shale section, totaled 4,368 ft. Since this was drilled with 6⅝-in. bit, operations were greatly handicapped. The small-sized hole allowed relatively little room in which to work, complicating the problem of wall pro-



One of the large deep drilling rigs on the Gulf Coast now engaged in drilling through shale and combating high gas pressures and salt water flows. Shown are two 20-in. duplex pumps and one triplex pump, which can be in parallel or in series in any combination to insure adequate circulating pressures and volume

tection and increasing the hazards during trouble. To complete the well, 5½-in. liner was run through the section and sealed into the 7⅝-in. protection casing. So slight was the wall clearance on this string that the 6¼-in. collars, which normally would have been used, had to be turned down to 5⅞-in. o.d.

Small-sized hole for such a depth through the shale was occasioned by the fact that 10¾-in. casing had been set at approximately 5,150 ft. This had been done to protect the Miocene producing sands of the field. The well then was drilled into the top of the shale section, but at that time, when trouble developed, the plan of making a deep test was abandoned. The 10¾-in. casing then was perforated at 5,132-43 ft., where the well was completed as a producer. When it was decided to make another attempt to deepen the hole, this casing limited the bit size to 9⅞-in., and when it became necessary to run the protection casing in the top of the shale, only 7⅝-in. pipe could be used.

Much Reaming Required

Drilling back to the shale section involved cleaning out and reaming the old hole left below the 10¾-in. casing. Originally no particular trouble was encountered in this portion of the hole. Cleaning out, sand bridges and caving gave considerable trouble on trips. The hole started to heave when the shale was reached. An attempt was made to run an electrical logging survey at 7,814 ft., but it was impossible to get the tool below 7,766 ft. because of bridging. Frequently, it was necessary to pull up and circulate and condition mud to keep from sticking pipe. Most trips required considerable reaming and sometime from 3 to 4 days to get back to bottom. A particularly bad place to pass was from 7,700 to 7,800 ft. Getting down to 8,215 ft., the pipe stuck, requiring 4,000 lb. pump pressure to break circulation and come out of the hole. On the return trip, it was found that the hole had caved to 8,151 ft., a loss of 64 ft. An overlying sand, which tended to wash out easily and which took mud when the mud weight was built up to hold the pressures, complicated control of the formations and increased the hazards of stuck pipe. Mud weight had to be carried from 12 to 13 lb. to hold the pressures.

Back on bottom, the condition of the hole was such that, to avoid further trouble with this section when drilling deeper, it was decided to set casing. Prior to doing this a slope test and a jeep survey were made. Running the pipe was accomplished with some difficulty. The pipe went in the hole freely to the shale, but from there on required much working, each successive joint becoming increasingly hard to lower. At 8,200 ft., less than a joint off bottom, the pipe stuck and could not be moved either down or up. To cement the string, after failing to get mud circulation, the cementing tool was set near bottom, at 8,167 ft., and through it 560 sacks of cement were squeezed, building up 2,500-lb. pressure. No returns were obtained.

For this part of the hole, eight round trips were made with seven rock bits being run, exclusive of the time required for pulling the liner, cleaning out, and squeezing perforations in the 10¾-in. casing where the well had been completed, 27 days were consumed. Much of this time was spent in reaming back to bottom on trips, although a number of shutdowns were occasioned by rig repairs or by rain and high water which interfered with keeping the mud in proper condition.

Water-base mud was employed, starting with a weight of approximately 10 lb. and a viscosity of from 35 to 40 cc. As drilling and reaming down proceeded, weight of the mud was built up gradually to around 12 to 13 lb., and viscosity increased over a wire range, reaching as high as 150 to 160 cc. at times at the last to assist in holding up the walls and facilitate removal of cuttings and cavings. In the shale, water loss of the mud was reduced to 6 cc., having a 3/32-in. filter cake with 12-lb. mud. Building up and maintaining the desired characteristics required a total of approximately 5,150 sacks of weighting material, more than 1,325 sacks of bentonite and gels, and 11,240 lb. of various chemicals, including quebracho, Peptoid, phosphate, sodium acid and S.A.P.P.

Mud Problems

Drilling out of the 7⅝-in. casing also was started with water-base mud which was built up to a weight of from 13 to 14 lb. with viscosity at 46 to 48 cc. Just below the casing where some of the original 9⅞-in. hole had been left when the pipe stuck off bottom, some trouble was experienced in building up the walls due to the loose shale cavings and cement coming in on the new 6⅝-in. hole. At this point it was decided to replace the fresh water-base mud with sodium silicate in brine solution, this being done gradually as drilling proceeded.

Weight control was an important phase of the mud program through the shale section. Pressures encountered necessitated maintenance of high-columnar weight. Starting with 13 to 14-lb. mud, the weight had to be built up by constant addition of weighting material until at a depth of 9,800 ft., 16-lb. mud was being carried. By the time 10,000 ft. was reached, the weight had to be increased to 17 lb. Throughout, the differential pressure at which the formations would take the mud was so slight that the mud weight had to be held within a range of 0.1 to 0.2 of a pound. Viscosity for the most part was carried within a range of 70 to 80 cc.

The principal concern was to prevent salt-water flows, encountered at frequent levels from around 9,400 ft. to bottom, from starting to break in and so contaminate the drilling mud that the desired properties necessary for holding up the shale walls could not be maintained. When bit was on bottom drilling or circulating no particular trouble seemed to arise with 17-lb. mud in the hole. However, when drilling stopped, and

Looking down on derrick floor of rig employing pressure drilling hookup to control high pressures and salt water flows on Gulf Coast. Such equipment has been employed successfully on various difficult jobs.

Adding weighting material to build up mud to control high and salt water flows on a deep Gulf Coast test. Provision of ample mud reserves to allow for loss of mud in formations complicated by heavy muds and high pressures, is essential. Shown is a portion of one of the large reserve pits used on a typical job

especially when necessary to pull up off bottom, the flows had a tendency to come in and follow the pipe up. This necessitated extreme caution when coming out of the hole, and led to the practice of dumping quantities of weighting material in the system and "slugging" the hole on trips with 18 to 19-lb. mud.

Mud-Control Precautions

Precautions taken to insure control of the mud and the well included use of a depth measuring gage in the mud pits by which constant watch was kept of the mud level. Since any rise in the level would indicate salt-water flows coming into system or gas breaking in to aerate and lighten the column, immediate steps could be taken to correct the trouble. In the same way, any loss of mud into the formations would be reflected by a lowering of the mud level in the pits. Also, the displacement of the drill pipe in the hole was accurately determined at all times, so that when pulling the pipe any abnormal variations in the volume of mud in the pits could be noted at all times. To insure uniform control, the system was equipped with a continuous mud-weight recorder.

Trips had to be made slowly to forestall any swabbing action. Prior to coming out of the hole, the system would be circulated and mud thoroughly conditioned. Pulling up a short distance, the hole would be "slugged," and at intervals the trip might have to be halted to circulate and condition the mud, and possibly dump and slug additional quantities of weighting material and mud. On some occasions it was necessary to go back and recirculate and condition the bottom of the hole before finally coming out.

Equal caution had to be exerted when going back into the hole, with particular care being taken not to disturb the walls any more than necessary. Return trips were made slowly, sometimes taking 3 or 4 days to get back on bottom, due to tight places and bridges which had to be reamed and cleaned out. On a few trips so much hole had to be reamed that when bottom was reached another trip had to be made for a new bit before making any additional hole. Frequent stops sometimes had to be made to circulate and condition mud, and with pressures constantly threatening to come in due to lowering of the mud consistency in the hole by the gradual infiltration of water flows and gas while the hole was standing.

A sand and sandy shale zone from about 10,400 ft. to near 10,600 ft. gave the most trouble. Substantial loss of mud occurred in this formation while it was being drilled and required the addition of considerable quantities of lost-circulation materials to the mud at that time. With the fluid infiltration and resultant building up of filter cake and accumulations of cuttings at this point, drill stem tried to stick, and had to be pulled up into the casing until the hole could be reamed and washed down and the trouble corrected. On trips from lower levels, some difficulty was experienced getting through this section.

Later, with bottom of hole at 11,020 ft., an attempt was made to run an electrical logging survey, in which it was impossible to get the logging electrodes below that level due to bridging and also the heavy mud. The instrument stuck at 10,473 ft., and in attempting to pull it, the line pulled out, leaving it in the hole. An overshot was run to recover it, but it was also impossible to get this down. Going back in with a wash pipe, consisting of joint of 4½-in., the hole was found to be bridged. After washing out, a second overshot trip was tried, this also proving unsuccessful.

Fishing Hazards Overcome

Because of the hazard to the hole by continued fishing, it was decided to attempt to drill by the logging tool, which was done successfully. Drilling back into the old hole, a piece of the fish was hit at a depth of 10,957 ft. This required two bit runs before being drilled out and bypassed. At 12,265 ft., another piece of the fish, one of the bronze weights which had dropped into the hole, was hit. This was milled for over 100 ft., and then was recovered in a core that was taken still lower in the hole.

The effectiveness of the practices and program followed was reflected in the ability of the operators to keep the hole clean and in condition to run the final liner despite the difficulties. The control maintained over the formations and pres-

sures made it possible to remain in the hole with the pipe for relatively long periods of time without hole caving or pipe sticking. At one time the pipe was in the hole for as long as 6 days. In the same way it was possible to remain out of the hole for relatively long periods and then get back to bottom. On various occasions the well was shut down for 4 and 5 days at a time for repairs and other delays. Heavy rains and high water at times not only stopped operations but also complicated mud control.

Forty-two cores, totaling 316 ft., were taken below 11,000 ft. These were taken with a wire-line core barrel, 22 of them in continuous coring from 11,074 to 11,130 ft., a total of 145 ft.; 19 at 11,562-719 ft., totaling 157 ft., and one at 12,512 ft. Six jeep surveys were run at different depths while drilling below 11,130 ft.

Bit and Trip Record

Forty-six round trips were made out of the open hole, consisting of 37 trips entirely out of the hole and 9 into the casing. Not included were the frequent instances in which pipe was pulled up for short distances and then run back without getting out of the open hole. Thirty-four bits, all of three-way fishtail type, were used. An additional 4⅝-in. rock bit was run inside the 5¼-in. liner to circulate and clean out the shale cutting in the bottom preparatory to cementing and perforating. Drill pipe was 3½-in. Over-all time for drilling out of the 7⅝-in. casing to bottom was 193 days.

In most heaving-shale wells, one of the greatest hazards and problems is running the final string of casing upon completion of the hole. Owing to the difficulty of holding up walls through caving and heaving formations, it often is impossible to get the string entirely to bottom, or the desired seating point. In this well, despite the unusual small clearance allowed by the 5½-in. pipe with 5⅞-in. turned down collars in 6⅝-in. hole, no trouble was experienced. The string, made up of 17 and 20-lb. pipe, totaling approximately 4,515 ft., packed off in the bottom of the 7⅝-in. casing and seated on bottom of the hole, was run in on the bottom of a string of 3½-in. drill pipe. With the liner set and packer collapsed in the 7⅝-in. casing, drill pipe was backed off and pulled.

The string was lowered in the hole without a guide shoe or float collars. The bottom end was "orange-peeled" and rounded in slightly so there would be no sharp edges to gouge the walls of the hole as it went down. Otherwise, the bottom of the string was entirely open, allowing the mud column to rise inside the pipe as the string was lowered, thus minimizing the volume of fluid displaced and forced out the hole behind the pipe. This practice was followed on the theory that if the pipe had been floated in with bottom closed, the volume of fluid displaced would have been forced out behind the pipe at such high velocity, due to the restricted clearance of the annulus, that the walls of the hole would be broken down and result in sticking the pipe. In this the action of the fluid on the walls would be accentuated by surges created in lowering successive joints of pipe.

Blowout Prevention

Since the bottom of the string was open, a means had to be devised for closing the top of the pipe as a precaution against a blowout while lowering the string. This consisted of a cap, made from a bull plug, which was screwed into the top joint of the string as it was lowered in the hole. The cap was fitted with a 1-in. outlet connection to a small line to the mud discharge to relieve pressure built up in the top by compression of the fluid column in the pipe and to allow for any fluid overflow to the mud pit. A small, high-pressure valve in the cap outlet connection permitted closing the top in event of trouble. Two caps were provided, one for the top of the string in the hole and the other to go on the next joint to be made up in the string. In this operation the only time the top of the casing in the hole was protected was when the cap on the string was removed to screw in the next joint, and this was for only a brief moment at a time.

To cement the liner, a cementing tool was run in on 2½-in. tubing and set about 10 ft. off bottom. Through this tool, 250 sacks of cement were squeezed around the bottom of the pipe. An additional 100 sacks each were squeezed through perforations in bottom and top.

Production tests were made through perforations at a succession of levels from bottom up. Attempts to make a well in the deeper sands, however, proved unsuccessful, and the hole has been plugged back and completed in one of the upper horizons of the field.

The well was drilled by Harry L. Edwards Drilling Co., under direct supervision of Glenn H. McCarthy, Inc.

New Volume Correction Tables for C₄ Hydrocarbons

A new and more accurate set of tables of liquid and vapor correction factors for mixtures of C_4 hydrocarbons has been issued by the U. S. Bureau of Standards as Letter Circular LC-757, entitled "Volume Correction Factors for C_4 Hydrocarbon Mixtures," compiled by C. S. Cragoe. Copies of this circular may be obtained without charge by requesting them from that bureau.

This compilation is prefaced by discussion of the factors which are standard for hydrocarbon liquids, and the corrections which are desirable for exact calculations of large volumes of these light hydrocarbons. The factors are given in tabulated figures and also in curves plotted from specific determinations on individual hydrocarbons, paraffins, olefins, diolefins, etc. The correction data are of especial interest, the author points out, in butadiene production and in other new developments in the light-hydrocarbon field.

Research Program on Drying of Gases

University of Oklahoma, Norman, is undertaking a research project on the drying of gases by activated alumina, from a chemical engineering point of view. The investigation, which is financially supported by Aluminum Co. of America, is under the direction of Dr. R. L. Huntington, chairman of the School of Chemical Engineering. He will have the part-time assistance of Profs. G. F. Russell and F. F. Blankenship.

John Stewart, president of Donner Estates, Inc., Philadelphia, has been elected a director of Deep Rock Oil Corp. to fill the vacancy caused by the death last June of John J. Shinners, Chicago.

Ernest C. Breeding, Houston, has been promoted to comptroller of The Texas Co., succeeding **Ira McFarland,** oldest company employe in point of service, who retired September 1 after 31 years as comptroller. **R. G. Rankin** has been named assistant comptroller to take Breeding's place.

Group of key operating personnel of Sohio Petroleum Co. in the West Edmond field, Oklahoma. Front: C. P. Shofstall, Joe S. Pearson (geologist), Paul Lauderback and Ed Klotz. Rear: E. W. Thomas, Floyd "Pete" Rosenlief (superintendent), and C. W. Dearmore

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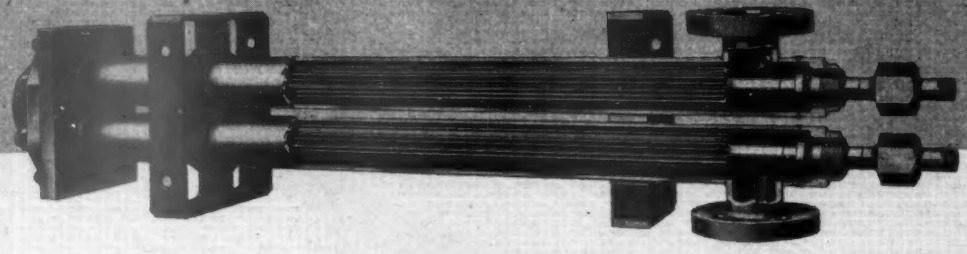

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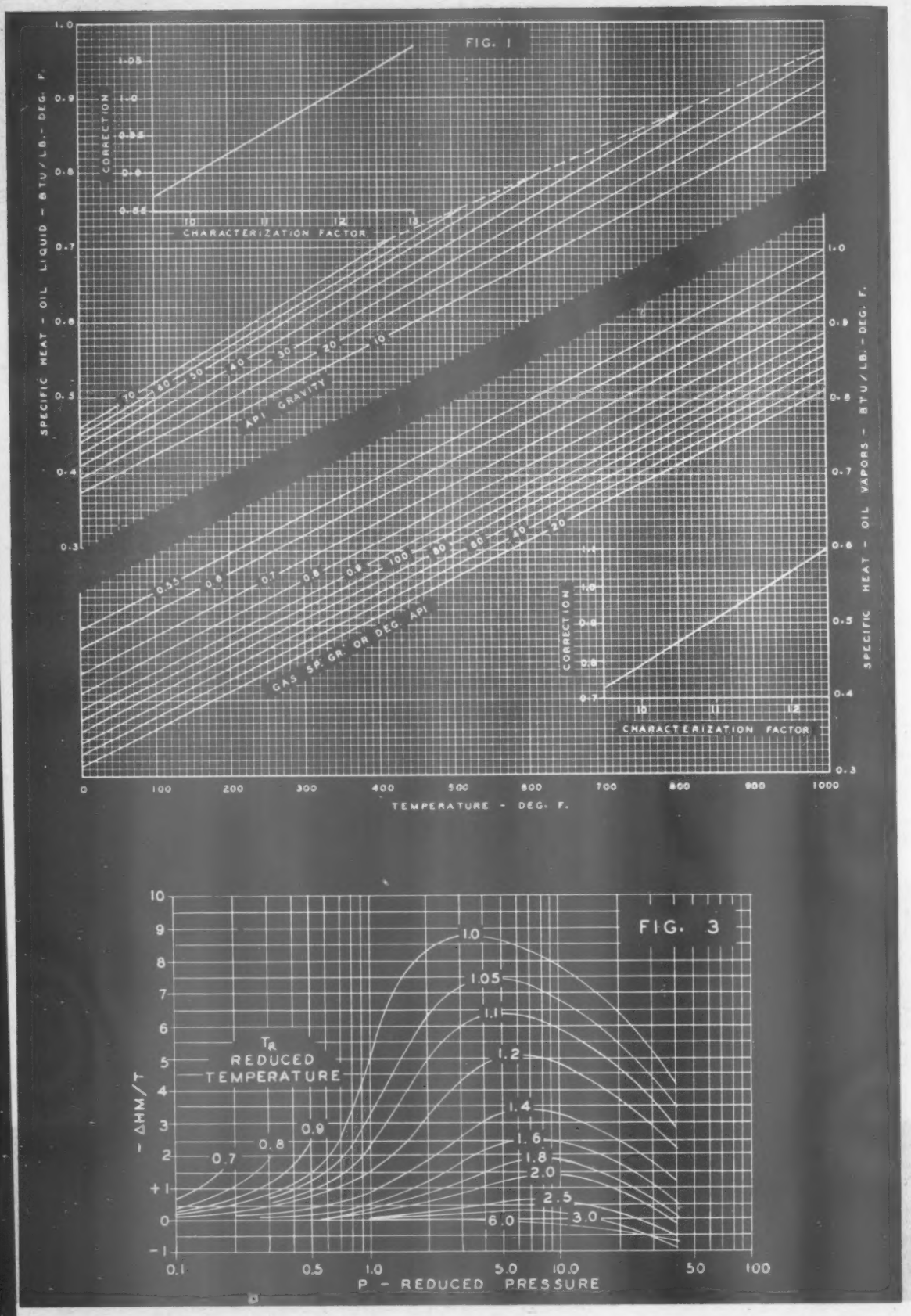


FIG. 1
SPECIFIC HEAT - OIL LIQUID - BTU/LB. - DEG. F.
SPECIFIC HEAT - OIL VAPORS - BTU/LB. - DEG. F.
CORRECTION
CHARACTERIZATION FACTOR
API GRAVITY
GAS SP. GR. OR DEG. API
TEMPERATURE - DEG. F.
FIG. 3
- ΔHM/T
T_R REDUCED TEMPERATURE
P - REDUCED PRESSURE

PRACTICAL REFINERY ENGINEERING

No. 14—Heat Balances

by Paul Buthod and B. W. Whiteley

THE heating load on exchangers and other heating equipment is computed by a heat balance covering the amount of material and required change in temperature. In the case of pure compounds, specific heats are readily available in tubular form. However, the composition of refinery liquids and vapors, in terms of pure compounds, is known only in rare instances.

Fortunately, specific heats of petroleum liquids and vapors can be correlated on the basis of physical properties which are readily measured and therefore are usually known. These data are reasonably accurate and afford a convenient means for determining specific heats of crudes, vapors, various cuts, etc.

The specific heats of petroleum liquids of varying A.P.I. gravities are shown in the top portion of Fig. 1. The A.P.I. gravities listed on the chart are corrected to 60° F. Since for a given gravity, the specific heat increases as a linear function with temperature, the mean specific heat can be read at the midpoint or average temperature.

Although this chart is applicable only to a Mid-Continent stock with a characterization factor of 11.8, specific heats for liquids with other characterization factors can be obtained by applying a correction as noted on the chart.

Characterization factors for some typical oils are as follows:

Pennsylvania stocks	12.2-12.5
Mid-Continent stocks	11.8-12.0
Gulf Coast stocks	11.0-11.5
Cracked gasolines	11.5-11.8
Cracking plant, combined feeds	10.5-11.5
Recycle stocks	10.0-11.0
Cracked residua	9.8-11.0

Characterization factors for other petroleum liquids can be determined from graphical correlations if any pair of the following physical properties is known:[1 2 3]

1. Kinematic viscosity.
2. A.P.I. gravity.
3. Average boiling point.
4. Average molecular weight.
5. Pseudocritical temperature.
6. Carbon-hydrogen ratio.

Specific heats for petroleum vapors of a known specific gravity (air = 1.00) or which are derived from liquids of a known A.P.I. gravity can be obtained from the lower portion of Fig. 1. The characterization factor in this instance refers to the liquid before vaporization.

All of the specific heats, as shown in Fig. 1, apply to petroleum liquids and gases at atmospheric pressure (14.7 lb. per sq. in. abs.). The specific heats of liquids are not affected to any appreciable extent by pressure.

In the case of gases or vapors at high pressures, however, a correction must be applied to the heat content as computed from specific heats at atmospheric pressure. These corrections (ΔH) can be obtained from Fig. 3. This chart is based on pseudoreduced temperatures and pressures and unless an analysis of the gas is available, it will be necessary to estimate the pseudocritical conditions from Fig. 2.

Using symbols as in the accompanying notation;

$$T_c/T = T_R \qquad P_c/P = P_R$$

and,

$$q = W\,[c(t_1 - t_2) + \Delta H_1 - \Delta H_2]$$

Use of the charts and methods for computing heat balances is illustrated in the following examples:

Example 1.—A natural gas with a specific gravity of 0.75 (air = 1.00) is under a pressure of 2,000 lb. per sq. in. and at a temperature of 250° F. The gas is to be cooled to a temperature of 100° F. at constant pressure. The cooling water is available at 50° F. and may be heated to 80° F. in the heat exchanger. Determine the amount of water in pounds per hour which will be required to cool 1,000 lb. per hour of the gas.

Solution.—The amount of heat to be removed from the gas may be calculated by means of the accompanying charts. The average specific heat, if the process were carried out at atmospheric pressure can be obtained from Fig. 1 (specific heat of vapors).

The average temperature is:

$$(250 + 100)/2 = 175°\ F.$$

From the chart, the average specific heat is found to be 0.51, and:

Initial temperature, $t_1 = 250°$ F.
Final temperature, $t_2 = 100°$ F.

Since the gas is at 2,000 lb. per sq. in., it will be necessary to correct the specific heat calculations for pressure.

The analysis of the gas is not given, so the pseudocritical temperature and pressure must be estimated from Fig. 2.

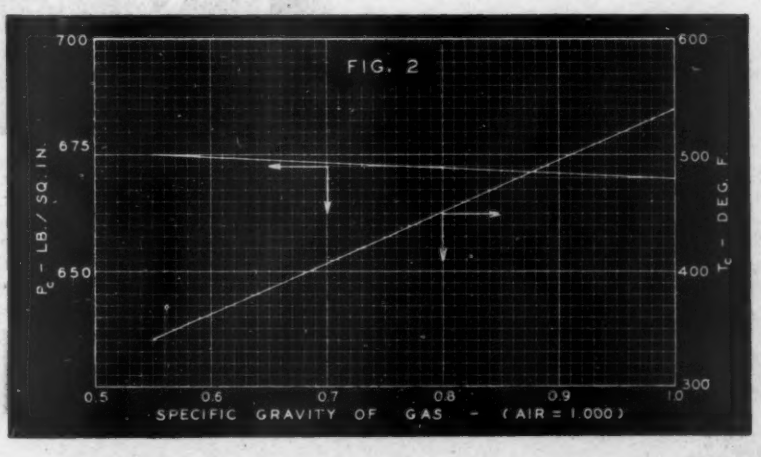
$T_c = 430°$ Rankine
$P_c = 672$ lb./sq. in. absolute

For the initial temperature condition:

$$T_R = (250 + 460)/430 = 1.65$$
$$P_R = 2{,}000/672 = 2.98$$

From Fig. 3:

$$-\Delta H_1\,M/T_1 = +1.60$$



The molecular weight of the gas is:

$$0.75 \times 29.0 = 21.8$$

and

$$\Delta H_1 = -1.60 \times (250 + 460)/21.8 = -52.1 \text{ B.t.u./lb.}$$

For the final temperature condition

$$T_R = (100 + 460)/430 = 1.30$$
$$P_R = 2{,}000/672 = 2.98$$

From Fig. 3:

$$-\Delta H_2 M/T_2 = +3.8$$

$$\Delta H_2 = -3.4 \times (100 + 460)/21.8 = -87.4 \text{ B.t.u./lb.}$$

Using the formula:

$$q = W_G [c(t_1 - t_2) + \Delta H_1 - \Delta H_2]$$
$$q = 1{,}000 [0.51 (250-100) + (-52.1) - (-87.4)]$$
$$q = +111{,}800 \text{ B.t.u./hr.}$$

The positive sign for "q" indicates that the gas is supplying heat and therefore is being cooled. Neglecting radiation and other losses, all of the heat supplied by the gas must be absorbed by the water, and:

$$q = 111{,}800 = W_W \times 1.0 \times (80 - 50)$$

and the required amount of water is:

$$W_W = 3{,}730 \text{ lb./hr.}$$

Example 2. — The gas-oil side stream from a fractionating tower is to be cooled from 500° F. to 150° F. by heat exchange with the incoming crude. The crude oil has a gravity of 40° A.P.I. and flows at the rate of 1,000 gal. per hour. The gas oil flows at the rate of 200 gal. per hour and has a gravity of 30° A.P.I. The crude oil has a characterization factor of 11.8 and the gas oil has a characterization factor of 11.5. If the crude oil enters at 60° F., determine the temperature at which it leaves the heat exchanger.

Solution. — The weights of the streams are:

Crude stream, W = 6,900 lb./hr.
Gas oil stream, W = 1,480 lb./hr.

No correction for characterization factor is required for the crude. The specific heat for the gas oil as obtained from Fig. 1, however, is corrected as follows:

Correction for characterization factor of 11.5 = 0.98.

Corrected Sp. Ht. = 0.585 × 0.98 = 0.573 B.t.u./lb.-°F.

Since the final temperature of the crude is unknown, a trial-and-error solution is necessary. A value for the specific heat is assumed and the final temperature is obtained from a heat balance. The specific heat as shown by Fig. 1, at the average of the initial and calculated final temperature is then checked against the assumed value for the specific heat.

The change in temperature for the gas oil is:

$$500 - 150 = 350° \text{ F.}$$

Since there is about five times as much crude as gas oil, the temperature change for the crude will be about one-fifth of 350° or 70° F. The average temperature of the crude, then, would be:

$$60 + 70/2 = 95° \text{ F.}$$

Trial 1.—Assume a Sp. Ht. = 0.48 (corresponding to 95° F.).

Heat balance:

$$1{,}480 \times 0.573 \times 350 = 6{,}900 \times 0.48 \times (t_2 - 60)$$

$$(t_2 - 60) = 90° \text{ F.}$$

The average temperature of the crude, then, is:

$$60 + 90/2 = 105° \text{ F.}$$

Check:

From Fig. 1, the specific heat corresponding to 105° F. is 0.485. This checks the initial assumed value for all practical purposes and another trial using a specific heat of 0.485 for the initial assumed value is not warranted.

The final temperature of the crude will be:

$$60 + 90 = 150° \text{ F.}$$

Notation:

- q = heat transferred, B.t.u./hr.
- W = weight of fluid stream, lb./hr.
- t = temperature, °F.
- T = temperature, °Rankine
- T_c = critical temperature, °Rankine
- T_R = reduced temperature
- P = pressure, lb./sq. in. absolute
- P_c = critical pressure, lb./sq. in. absolute
- P_R = reduced pressure
- c = specific heat, B.t.u./lb.°F.
- M = molecular weight, lb./mol
- ΔH = correction for enthalpy or heat content with change in pressure, B.t.u./lb.

Subscript 1 = initial conditions of pressure and temperature

Subscript 2 = final conditions of pressure and temperature

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CEMENT—SLURRY RATIOS

FOR a given percentage of mixing water to cement (by weight), or water-cement ratio, a certain volume of slurry will be obtained. The slurry, for a given water-cement ratio, may be expressed either in units of specific volume (cubic feet per sack), or in units of density (pounds per gallon). This relation, for one cement, is illustrated in Fig. 1 (after Coleman and Corrigan). It is necessary to use sufficient water in the slurry to assure complete hydration and hydrolysis of the cement constituents and to obtain sufficient fluidity. On the other hand, a good oil-well cement should set as a dense and durable mass and have extremely low permeability. Water channeling or "chimneys" and water pockets must be absent, and a poor cement set may easily result from using excessive water.

A technical definition of excess water has been given as "any water used over the maximum amount that can be mixed with a given amount of cement and still produce a slurry with which a ratio of set volume to slurry volume of 100 per cent can be attained." The ratio of set volume to slurry volume increases as the water-cement ratio is decreased. It is desirable to maintain the ratio of set-to-slurry volume near 100 per cent to avoid "excess water" and the possibility of water channels and pockets in the set.

Channeling Causes Failures

Failures in casing cementation, in large part, are caused by channeling, by off-center casing, and by the presence of a mud cake between the set cement and the formation. Through the use of relatively large-scale apparatus simulating conditions prevailing during the cementing of oil wells, Jones and Berdine investigated the factors influencing oil-well cementing failures caused by poor bonds between set cement and formation, and means for improving these bonds. Their conclusions were as follows: "Channeling and chimney formation of cement in the annulus are unlikely in the immediate region of the shoe, but may occur near the top of the cement column.

"Wherever cement slurry is applied opposite formations having appreciable permeability, a residual mud cake will remain between the set cement and the formation, unless specific means are employed to effect its removal. The presence of collars, movement of the casing, or circulation of water may reduce the thickness of the mud cake slightly, but will not remove it completely.

"Where the casing rests against the walls of the hole, residual cakes will be thicker than normal. There is a tendency for the cement slurry to be excluded from such regions of proximity, thus leaving longitudinal stringers of mud cake with no cement between the casing and the formation.

"Three methods were found to be effective in removing mud cakes:

"1. Hydraulic action by direct impingement of fluid jets (such as that induced by down-whirler shoes) against the walls of the hole.

"2. Mechanical scraping by the use of suitable mechanical devices on the casing, and alternately raising and lowering the casing. This is effective only over areas where scrapers or scratchers contact the wall of the hole.

"3. Acid treatment gave best results under atmospheric-pressure conditions. Laboratory tests at high pressure indicate, but do not prove, that effective mud-cake removal under these conditions may be obtained."

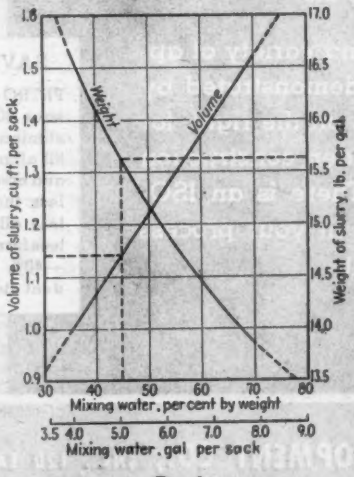

Fig. 1

Acid soluble cement is a special purpose material which can be of considerable utility in certain applications. Acid soluble cement contains from 40 to 45 per cent finely ground calcium carbonate, and the set material is rather rapidly soluble in 15 per cent hydrochloric acid. Regular cement, on the other hand, will react with acid at first, but shortly an impervious silica gel is formed on the surface which prevents further contact with the acid. Acid soluble cements have such possible uses as the blanking off or squeezing of shallow productive zones for protection, in order to drill deeper; in forming temporary bridges while testing or reworking upper formations; in plugging back in a formation to attempt to shut off water, etc. Such cements can be removed by handling the acid in a bailer or other means, but quite often the removal is done most effectively with an acid jet gun.

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The Refiner's Notebook

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL

Strapping of Tanks

TANKS from which movements to the market are made at frequent intervals should be strapped by professionals. The cost is only several hundred dollars. Professional strapping companies should be employed for strapping marketing tanks, spheres, spheroids, floating-roof tanks and any freak-shaped vessels. The capacity of tanks used for movements within the refinery can be strapped and/or computed with sufficient accuracy by the methods given herein. More detailed instructions are given in A.P.I. Code 25, and in Instructions for Measuring Sampling and Testing Petroleum Shipments, Standard Inspection Laboratory, Standard Oil Development Co.

Horizontal Cylindrical Tanks

Internal bracings, etc. (deadwood) are seldom used in these tanks, but if the tank contains any deadwood it should be handled as given below under Vertical Tanks. Several types of ends are employed:

1. **Bumped heads.** — Spherical segment having radius equal to diameter of cylindrical portion of tank and attached directly to the cylindrical portion.

2. **Dished or basket heads.**—Same as 1 except connected by means of a knuckle connection having a radius larger than 6 per cent of the diameter of the cylindrical portion of the tank, but never with a radius less than three times the thickness of the plate.

3. **Dome ends.** — Spherical segment (hemisphere) of radius equal to half the diameter of the cylinder. This is a recent trend particularly for high-pressure tanks.

The length of the cylindrical portion of the tank is measured between the heads in the case of bumped heads, but between the bends of the knuckle-connection in the case of dished or basket heads. Tables 1 and 2 (see next page) are based on measurements taken in this way. The cylindrical portion is strapped at each plant by laying a tape around the tank and the outside diameter is computed by dividing the average circumference by 3.1416. The thicknesses of the plates are measured using drilled holes if the tank is corroded. The inside diameter is computed by subtracting twice the average plate thickness from the outside diameter. Tables 1 and 2 are based on percentages of diameter and percentages of full capacity and hence can be used on any size tank. Up to half of the diameter these tables are used as per cent full, and past half-full are used as per cent empty. Tank-strapping or capacity tables are computed as follows:

1. Accurately compute capacity of cylindrical portion by Equations 1 or 2.

2. Accurately compute capacity of heads using Equations 3 or 4 unless ends are domes or other freak shapes.

3. In Column 1 of table, set down the depth of liquid in the tank, using ¼ in. increases in depth from zero to the full depth (or inside diameter).

4. In Column 2 tabulate the percentage of full depth by dividing the depth by the inside diameter. This is listed as "%d" in Tables 1 and 2.

5. In Column 3 list the percentage of full for the cylindrical portion using Table 1. Approximate interpolation between values given in Table 1 may be made but mathematical interpolation is seldom justified. For values above 50 per cent full, the figures listed in Column 3 should be the per cent of the tank that is empty. These figures are "%c" taken from Table 1.

6. In Column 4 list "%c" from Table 2 for the bumped ends.

7. In Column 5 list the capacity of the cylindrical portion by multiplying (usually slide rule) Column 3 by the full capacity of the cylinder. Above half full list the difference between the full capacity and the empty part of the cylinder listed in Column 3.

8. In Column 6 list the capacity of the heads by multiplying Column 4 by the full capacity of the heads as in Item 7.

9. In Column 7 list the sum of Columns 5 and 6. These figures are capacity of tank and should be transferred from the computation sheets to final Strapping Table.

Regular Vertical Tanks

Volumes are computed by the direct use of Equations 1 or 2 and the depth of liquid in the tank. Strappings are taken at each ring of plate and corrections must be made for any deadwood such as heating coils, steel supports, base plates, rings of rivets, internal lines, etc. The positions of deadwood are measured vertically and corrections are applied at these depths. Direct measurements may be made and the volume of deadwood computed, or if weights are known (as with structural steel or pipe) the weight of a cubic inch of steel is 0.284 lb. (or 490 lb. per cu. ft.).

Eq. 1. Volume of cylinder $= \frac{0.7854}{231} (\text{dia.})^2 = 0.0034$ (inches dia.)^2, gallons per inch of length.

Eq. 2. Volume of cylinder $= \frac{0.7854\ (\text{dia.})^2}{231\ (42)} = 0.00008095$ (inches dia.)^2, barrels per inch of length.

Eq. 3. Volume of 2 regular heads = 0.000466 (inches dia.)^3, gallons per inch of length.

Eq. 4. Volume of 2 regular heads = 0.0000111 (inches dia.)^3, barrels per inch of length.

Eq. 5. Volume of 2 hemisphere heads = 0.002268 (inches dia.)^3, gallons per inch of length.

Eq. 6. Volume of 2 hemisphere heads = 0.000054 (inches dia.)^3, barrels per inch of length.

No. 10 in a series by W. L. Nelson, professor of petroleum refinery engineering, University of Tulsa

TABLE 1—TABLE FOR GAGING CYLINDRICAL TANKS—HORIZONTAL CYLINDRICAL PORTION ONLY

% d = percentage of total diameter of tank
% c = percentage of total capacity of tank

% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c
0.1	0.0053	5.1	1.9250	10.1	5.2805	15.1	9.497	20.1	14.341	25.1	19.662	30.1	25.350	35.1	31.314	40.1	37.490	45.1	43.775
0.2	0.0152	5.2	1.9814	10.2	5.3580	15.2	9.588	20.2	14.444	25.2	19.773	30.2	25.467	35.2	31.436	40.2	37.606	45.2	43.902
0.3	0.0279	5.3	2.0383	10.3	5.4350	15.3	9.679	20.3	14.547	25.3	19.884	30.3	25.584	35.3	31.558	40.3	37.731	45.3	44.028
0.4	0.0429	5.4	2.0956	10.4	5.5122	15.4	9.771	20.4	14.649	25.4	19.995	30.4	25.701	35.4	31.680	40.4	37.856	45.4	44.155
0.5	0.0600	5.5	2.1535	10.5	5.5902	15.5	9.863	20.5	14.751	25.5	20.106	30.5	25.818	35.5	31.802	40.5	37.981	45.5	44.282
0.6	0.0788	5.6	2.2116	10.6	5.6690	15.6	9.956	20.6	14.854	25.6	20.217	30.6	25.935	35.6	31.924	40.6	38.106	45.6	44.409
0.7	0.0992	5.7	2.2705	10.7	5.7472	15.7	10.048	20.7	14.957	25.7	20.328	30.7	26.052	35.7	32.046	40.7	38.231	45.7	44.538
0.8	0.1212	5.8	2.3297	10.8	5.8258	15.8	10.142	20.8	15.060	25.8	20.439	30.8	26.170	35.8	32.168	40.8	38.355	45.8	44.668
0.9	0.1445	5.9	2.3895	10.9	5.9050	15.9	10.234	20.9	15.163	25.9	20.550	30.9	26.288	35.9	32.290	40.9	38.479	45.9	44.790
1.0	0.1692	6.0	2.4497	11.0	5.9848	16.0	10.327	21.0	15.267	26.0	20.661	31.0	26.407	36.0	32.412	41.0	38.604	46.0	44.918
1.1	0.1952	6.1	2.5105	11.1	6.0645	16.1	10.422	21.1	15.371	26.1	20.773	31.1	26.524	36.1	32.534	41.1	38.730	46.1	45.043
1.2	0.2223	6.2	2.5715	11.2	6.1445	16.2	10.515	21.2	15.475	26.2	20.886	31.2	26.642	36.2	32.657	41.2	38.856	46.2	45.171
1.3	0.2508	6.3	2.6333	11.3	6.2255	16.3	10.609	21.3	15.579	26.3	20.998	31.3	26.760	36.3	32.780	41.3	38.982	46.3	45.298
1.4	0.2800	6.4	2.6952	11.4	6.3060	16.4	10.703	21.4	15.683	26.4	21.110	31.4	26.878	36.4	32.902	41.4	39.108	46.4	45.424
1.5	0.3104	6.5	2.7579	11.5	6.3870	16.5	10.797	21.5	15.787	26.5	21.222	31.5	26.996	36.5	33.025	41.5	39.233	46.5	45.550
1.6	0.3419	6.6	2.8211	11.6	6.4685	16.6	10.893	21.6	15.892	26.6	21.334	31.6	27.114	36.6	33.147	41.6	39.358	46.6	45.678
1.7	0.3744	6.7	2.8845	11.7	6.5500	16.7	10.988	21.7	15.998	26.7	21.447	31.7	27.232	36.7	33.269	41.7	39.482	46.7	45.803
1.8	0.4077	6.8	2.9483	11.8	6.6320	16.8	11.082	21.8	16.101	26.8	21.560	31.8	27.351	36.8	33.392	41.8	39.608	46.8	45.930
1.9	0.4421	6.9	3.0127	11.9	6.7145	16.9	11.178	21.9	16.206	26.9	21.672	31.9	27.470	36.9	33.515	41.9	39.735	46.9	46.058
2.0	0.4773	7.0	3.0771	12.0	6.7970	17.0	11.273	22.0	16.312	27.0	21.785	32.0	27.589	37.0	33.638	42.0	39.862	47.0	46.183
2.1	0.5134	7.1	3.1426	12.1	6.8795	17.1	11.369	22.1	16.418	27.1	21.898	32.1	27.708	37.1	33.762	42.1	39.988	47.1	46.311
2.2	0.5501	7.2	3.2082	12.2	6.9630	17.2	11.465	22.2	16.524	27.2	22.011	32.2	27.827	37.2	33.885	42.2	40.114	47.2	46.438
2.3	0.5881	7.3	3.2742	12.3	7.0460	17.3	11.561	22.3	16.630	27.3	22.125	32.3	27.946	37.3	34.008	42.3	40.240	47.3	46.565
2.4	0.6263	7.4	3.3408	12.4	7.1305	17.4	11.657	22.4	16.737	27.4	22.239	32.4	28.065	37.4	34.131	42.4	40.365	47.4	46.693
2.5	0.6660	7.5	3.4075	12.5	7.2145	17.5	11.754	22.5	16.842	27.5	22.353	32.5	28.184	37.5	34.254	42.5	40.490	47.5	46.819
2.6	0.7061	7.6	3.4749	12.6	7.2990	17.6	11.851	22.6	16.949	27.6	22.467	32.6	28.302	37.6	34.377	42.6	40.615	47.6	46.947
2.7	0.7470	7.7	3.5426	12.7	7.3830	17.7	11.949	22.7	17.055	27.7	22.581	32.7	28.422	37.7	34.501	42.7	40.741	47.7	47.074
2.8	0.7886	7.8	3.6106	12.8	7.4680	17.8	12.046	22.8	17.161	27.8	22.695	32.8	28.543	37.8	34.625	42.8	40.869	47.8	47.201
2.9	0.8310	7.9	3.6790	12.9	7.5540	17.9	12.143	22.9	17.269	27.9	22.810	32.9	28.660	37.9	34.749	42.9	40.994	47.9	47.329
3.0	0.8742	8.0	3.7480	13.0	7.6390	18.0	12.240	23.0	17.376	28.0	22.923	33.0	28.781	38.0	34.873	43.0	41.120	48.0	47.457
3.1	0.9179	8.1	3.8171	13.1	7.7245	18.1	12.338	23.1	17.483	28.1	23.038	33.1	28.899	38.1	34.996	43.1	41.246	48.1	47.583
3.2	0.9625	8.2	3.8869	13.2	7.8110	18.2	12.437	23.2	17.590	28.2	23.152	33.2	29.020	38.2	35.119	43.2	41.372	48.2	47.710
3.3	1.0075	8.3	3.9570	13.3	7.8970	18.3	12.535	23.3	17.698	28.3	23.266	33.3	29.140	38.3	35.242	43.3	41.499	48.3	47.837
3.4	1.0533	8.4	4.0276	13.4	7.9840	18.4	12.633	23.4	17.806	28.4	23.380	33.4	29.260	38.4	35.368	43.4	41.628	48.4	47.965
3.5	1.0998	8.5	4.0983	13.5	8.0710	18.5	12.732	23.5	17.913	28.5	23.494	33.5	29.380	38.5	35.941	43.5	41.749	48.5	48.093
3.6	1.1470	8.6	4.1696	13.6	8.1580	18.6	12.831	23.6	18.022	28.6	23.611	33.6	29.500	38.6	35.615	43.6	41.876	48.6	48.220
3.7	1.1947	8.7	4.2411	13.7	8.2450	18.7	12.930	23.7	18.130	28.7	23.728	33.7	29.620	38.7	35.739	43.7	42.002	48.7	48.348
3.8	1.2432	8.8	4.3131	13.8	8.3330	18.8	13.030	23.8	18.240	28.8	23.842	33.8	29.740	38.8	35.865	43.8	42.129	48.8	48.475
3.9	1.2921	8.9	4.3855	13.9	8.4210	18.9	13.130	23.9	18.348	28.9	23.957	33.9	29.860	38.9	35.988	43.9	42.257	48.9	48.603
4.0	1.3418	9.0	4.4582	14.0	8.5090	19.0	13.229	24.0	18.457	29.0	24.072	34.0	29.981	39.0	36.110	44.0	42.383	49.0	48.729
4.1	1.3920	9.1	4.5312	14.1	8.5975	19.1	13.329	24.1	18.566	29.1	24.187	34.1	30.102	39.1	36.234	44.1	42.510	49.1	48.857
4.2	1.4429	9.2	4.6045	14.2	8.6860	19.2	13.429	24.2	18.675	29.2	24.302	34.2	30.223	39.2	36.359	44.2	42.637	49.2	48.983
4.3	1.4941	9.3	4.6782	14.3	8.7755	19.3	13.529	24.3	18.784	29.3	24.418	34.3	30.344	39.3	36.483	44.3	42.762	49.3	49.112
4.4	1.5461	9.4	4.7526	14.4	8.8645	19.4	13.630	24.4	18.892	29.4	24.535	34.4	30.465	39.4	36.608	44.4	42.890	49.4	49.239
4.5	1.5986	9.5	4.8274	14.5	8.9545	19.5	13.731	24.5	19.010	29.5	24.651	34.5	30.587	39.5	36.732	44.5	43.018	49.5	49.366
4.6	1.6515	9.6	4.9015	14.6	9.0440	19.6	13.832	24.6	19.110	29.6	24.769	34.6	30.708	39.6	36.856	44.6	43.142	49.6	49.494
4.7	1.7052	9.7	4.9769	14.7	9.1345	19.7	13.934	24.7	19.220	29.7	24.884	34.7	30.829	39.7	36.981	44.7	43.266	49.7	49.631
4.8	1.7594	9.8	5.0523	14.8	9.2240	19.8	14.035	24.8	19.330	29.8	25.000	34.8	30.950	39.8	37.106	44.8	43.397	49.8	49.748
4.9	1.8142	9.9	5.1280	14.9	9.3150	19.9	14.146	24.9	19.440	29.9	25.116	34.9	31.071	39.9	37.230	44.9	43.531	49.9	49.877
5.0	1.8693	10.0	5.2040	15.0	9.4060	20.0	14.238	25.0	19.551	30.0	25.233	35.0	31.192	40.0	37.355	45.0	43.648	50.0	50.000

TABLE 2—TABLE FOR GAGING BUMPED ENDS OF HORIZONTAL CYLINDRICAL TANKS

(Radius of Heads Equal to Diameter of Cylindrical Portion)

% d = percentage of total diameter of tank
% c = percentage of total contents of both bumped ends

% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c	% d	% c
0.1	0.00	5.1	0.32	10.1	1.62	15.1	4.18	20.1	7.99	25.1	12.95	30.1	19.06	35.1	26.05	40.1	33.74	45.1	41.77
0.2	0.00	5.2	0.34	10.2	1.66	15.2	4.24	20.2	8.09	25.2	13.06	30.2	19.19	35.2	26.20	40.2	33.90	45.2	41.94
0.3	0.00	5.3	0.36	10.3	1.69	15.3	4.31	20.3	8.19	25.3	13.17	30.3	19.32	35.3	26.35	40.3	34.05	45.3	42.11
0.4	0.00	5.4	0.38	10.4	1.73	15.4	4.38	20.4	8.28	25.4	13.29	30.4	19.43	35.4	26.50	40.4	34.20	45.4	42.28
0.5	0.01	5.5	0.40	10.5	1.77	15.5	4.44	20.5	8.38	25.5	13.40	30.5	19.55	35.5	26.65	40.5	34.35	45.5	42.45
0.6	0.01	5.6	0.41	10.6	1.81	15.6	4.50	20.6	8.46	25.6	13.51	30.6	19.68	35.6	26.80	40.6	34.50	45.6	42.61
0.7	0.01	5.7	0.43	10.7	1.85	15.7	4.57	20.7	8.54	25.7	13.63	30.7	19.81	35.7	26.95	40.7	34.65	45.7	42.77
0.8	0.01	5.8	0.45	10.8	1.89	15.8	4.63	20.8	8.63	25.8	13.75	30.8	19.94	35.8	27.10	40.8	34.80	45.8	42.93
0.9	0.01	5.9	0.47	10.9	1.94	15.9	4.70	20.9	8.72	25.9	13.87	30.9	20.07	35.9	27.25	40.9	34.95	45.9	43.09
1.0	0.01	6.0	0.49	11.0	1.98	16.0	4.77	21.0	8.81	26.0	13.98	31.0	20.22	36.0	27.40	41.0	35.10	46.0	43.25
1.1	0.01	6.1	0.50	11.1	2.03	16.1	4.83	21.1	8.89	26.1	14.10	31.1	20.37	36.1	27.55	41.1	35.26	46.1	43.41
1.2	0.01	6.2	0.52	11.2	2.07	16.2	4.90	21.2	8.97	26.2	14.22	31.2	20.52	36.2	27.70	41.2	35.42	46.2	43.57
1.3	0.01	6.3	0.53	11.3	2.11	16.3	4.96	21.3	9.06	26.3	14.34	31.3	20.67	36.3	27.84	41.3	35.58	46.3	43.73
1.4	0.02	6.4	0.54	11.4	2.15	16.4	5.03	21.4	9.15	26.4	14.46	31.4	20.82	36.4	27.99	41.4	35.75	46.4	43.89
1.5	0.02	6.5	0.56	11.5	2.20	16.5	5.10	21.5	9.24	26.5	14.58	31.5	20.97	36.5	28.13	41.5	35.92	46.5	44.05
1.6	0.02	6.6	0.58	11.6	2.24	16.6	5.17	21.6	9.34	26.6	14.70	31.6	21.11	36.6	28.28	41.6	36.08	46.6	44.22
1.7	0.02	6.7	0.60	11.7	2.29	16.7	5.25	21.7	9.44	26.7	14.82	31.7	21.25	36.7	28.43	41.7	36.24	46.7	44.38
1.8	0.02	6.8	0.62	11.8	2.33	16.8	5.32	21.8	9.54	26.8	14.94	31.8	21.39	36.8	28.59	41.8	36.39	46.8	44.54
1.9	0.02	6.9	0.64	11.9	2.38	16.9	5.40	21.9	9.64	26.9	15.06	31.9	21.52	36.9	28.75	41.9	36.55	46.9	44.71
2.0	0.02	7.0	0.66	12.0	2.43	17.0	5.48	22.0	9.74	27.0	15.19	32.0	21.65	37.0	28.90	42.0	36.70	47.0	44.88
2.1	0.03	7.1	0.68	12.1	2.48	17.1	5.55	22.1	9.84	27.1	15.31	32.1	21.79	37.1	29.06	42.1	36.86	47.1	45.06
2.2	0.03	7.2	0.70	12.2	2.54	17.2	5.63	22.2	9.95	27.2	15.43	32.2	21.93	37.2	29.20	42.2	37.02	47.2	45.23
2.3	0.04	7.3	0.73	12.3	2.60	17.3	5.71	22.3	10.03	27.3	15.56	32.3	22.07	37.3	29.35	42.3	37.18	47.3	45.31
2.4	0.04	7.4	0.75	12.4	2.65	17.4	5.78	22.4	10.12	27.4	15.66	32.4	22.20	37.4	29.50	42.4	37.34	47.4	45.50
2.5	0.05	7.5	0.78	12.5	2.70	17.5	5.86	22.5	10.22	27.5	15.80	32.5	22.34	37.5	29.65	42.5	37.50	47.5	45.77
2.6	0.05	7.6	0.81	12.6	2.75	17.6	5.94	22.6	10.32	27.6	15.92	32.6	22.47	37.6	29.80	42.6	37.67	47.6	45.96
2.7	0.06	7.7	0.84	12.7	2.80	17.7	6.02	22.7	10.42	27.7	16.04	32.7	22.60	37.7	29.95	42.7	37.83	47.7	46.19
2.8	0.06	7.8	0.87	12.8	2.85	17.8	6.10	22.8	10.53	27.8	16.16	32.8	22.74	37.8	30.10	42.8	37.99	47.8	46.39
2.9	0.07	7.9	0.90	12.9	2.90	17.9	6.17	22.9	10.63	27.9	16.28	32.9	22.87	37.9	30.26	42.9	38.16	47.9	46.46
3.0	0.07	8.0	0.92	13.0	2.95	18.0	6.25	23.0	10.72	28.0	16.40	33.0	23.00	38.0	30.42	43.0	38.32	48.0	46.63
3.1	0.08	8.1	0.95	13.1	3.01	18.1	6.33	23.1	10.82	28.1	16.53	33.1	23.14	38.1	30.58	43.1	38.49	48.1	46.80
3.2	0.08	8.2	0.98	13.2	3.06	18.2	6.41	23.2	10.93	28.2	16.65	33.2	23.28	38.2	30.74	43.2	38.65	48.2	46.96
3.3	0.09	8.3	1.01	13.3	3.12	18.3	6.49	23.3	11.04	28.3	16.77	33.3	23.41	38.3	30.91	43.3	38.81	48.3	47.13
3.4	0.10	8.4	1.06	13.4	3.17	18.4	6.57	23.4	11.14	28.4	16.90	33.4	23.55	38.4	31.08	43.4	38.97	48.4	47.30
3.5	0.11	8.5	1.08	13.5	3.22	18.5	6.64	23.5	11.25	28.5	17.02	33.5	23.69	38.5	31.25	43.5	39.13	48.5	47.46
3.6	0.12	8.6	1.11	13.6	3.28	18.6	6.72	23.6	11.36	28.6	17.14	33.6	23.84	38.6	31.40	43.6	39.30	48.6	47.63
3.7	0.13	8.7	1.14	13.7	3.33	18.7	6.80	23.7	11.47	28.7	17.27	33.7	23.99	38.7	31.56	43.7	39.46	48.7	47.77
3.8	0.14	8.8	1.17	13.8	3.39	18.8	6.88	23.8	11.58	28.8	17.39	33.8	24.15	38.8	31.73	43.8	39.62	48.8	47.93
3.9	0.15	8.9	1.20	13.9	3.44	18.9	6.96	23.9	11.69	28.9	17.51	33.9	24.31	38.9	31.87	43.9	39.78	48.9	48.09
4.0	0.16	9.0	1.23	14.0	3.50	19.0	7.05	24.0	11.80	29.0	17.63	34.0	24.45	39.0	32.02	44.0	39.95	49.0	48.25
4.1	0.17	9.1	1.26	14.1	3.56	19.1	7.13	24.1	11.90	29.1	17.76	34.1	24.59	39.1	32.16	44.1	40.12	49.1	48.42
4.2	0.18	9.2	1.30	14.2	3.62	19.2	7.21	24.2	12.01	29.2	17.89	34.2	24.74	39.2	32.31	44.2	40.29	49.2	48.59
4.3	0.19	9.3	1.33	14.3	3.68	19.3	7.29	24.3	12.12	29.3	18.02	34.3	24.89	39.3	32.46	44.3	40.46	49.3	48.76
4.4	0.20	9.4	1.36	14.4	3.74	19.4	7.37	24.4	12.22	29.4	18.15	34.4	25.05	39.4	32.60	44.4	40.62	49.4	48.93
4.5	0.21	9.5	1.40	14.5	3.80	19.5	7.46	24.5	12.32	29.5	18.27	34.5	25.20	39.5	32.75	44.5	40.79	49.5	49.10
4.6	0.22	9.6	1.43	14.6	3.87	19.6	7.55	24.6	12.43	29.6	18.40	34.6	25.36	39.6	32.91	44.6	40.95	49.6	49.28
4.7	0.24	9.7	1.46	14.7	3.93	19.7	7.63	24.7	12.54	29.7	18.53	34.7	25.52	39.7	33.06	44.7	41.11	49.7	49.46
4.8	0.25	9.8	1.50	14.8	4.00	19.8	7.72	24.8	12.66	29.8	18.66	34.8	25.68	39.8	33.32	44.8	41.27	49.8	49.64
4.9	0.28	9.9	1.54	14.9	4.05	19.9	7.81	24.9	12.77	29.9	18.80	34.9	25.84	39.9	33.45	44.9	41.44	49.9	49.82
5.0	0.30	10.0	1.58	15.0	4.12	20.0	7.90	25.0	12.89	30.0	18.93	35.0	25.90	40.0	33.58	45.0	41.60	50.0	50.00

PIPE LINES

Tennessee Line Completion in Sight

For the Tennessee Gas & Transmission Co. 1,265-mile Corpus Christi, Tex.-Cornwell, W. Va., line, 1,160 miles had been welded and 1,129 miles backfilled at the beginning of this week; 544 miles had been blown and 110 miles finally tested. All of the compressor stations have been substantially completed. Wherever gas has been available engines have been turned over. Spreads of eight contractors are still in the field. In several cases spreads have only a few miles to go to finish their sections.

Stanolind to Build Casper-Welch Line

For the crude-oil system of Stanolind Pipe Line Co., 31½ miles of 12-in. will be laid soon between Casper and Welch, Wyo. The undertaking is known as the Teapot-Cooper Junction-Welch project.

Taking up approximately 9 miles of 8-in. and 27 miles of 12-in. line between Welch and Teapot has been contracted by Eastern Construction Co., which is commencing operations. The pipe taken up is screw pipe which was laid in 1922 and 1923. The Eastern company will recondition and double-joint the pipe at two points: at Casper, a yard already set up for Stanolind operations will be utilized; at Glenrock the contractor will set up a new yard.

In addition to the pipe to be taken up Stanolind will use 12-in. pipe from stock. After much consideration of the problem, a decision was reached to coat and wrap the new line in accordance with customary specifications of the Stanolind company. The laying of the line has been contracted by I. C. Little, who will move to the job early in October after completing sections contracted on Stanolind's Elk Basin-Casper crude-oil line. In the middle of last week it was reported that I. C. Little was working to complete the final 30 miles of the Elk Basin outlet in an area of rough country where two spreads were progressing toward each other. Over more favorable ground, Sharman & Allen completed its section on August 31. Laying of the entire Elk Basin-Casper line will be finished on the completion of the I. C. Little sections.

Welding of 41 miles of 16-in. line in three loops on the Stanolind trunk line in the Drumright, Okla.-Sycamore, Kans., area has been finished. Early this week the only work remaining was tie-in, backfilling and cleanup. It is expected that oil will flow through the loops within 5 days after tie-in.

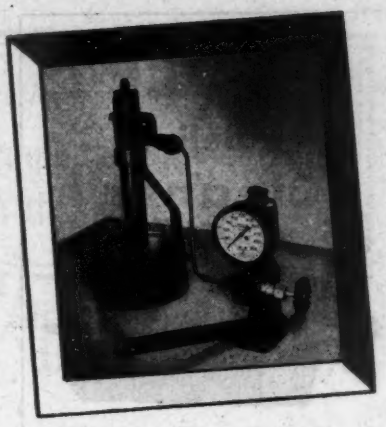
Tennessee Natural Plans to Supply Nashville With Gas

WASHINGTON.—Tennessee Natural Gas Lines, Inc., Chattanooga, has applied to Federal Power Commission for permission to construct and operate a pipe-line system to make natural gas available for Nashville. The proposed system will consist of a 10¾-in. line originating at a point of connection with Tennessee Gas & Transmission Co.'s facilities near Ashland City, Tenn., and extending about 17 miles to Nashville. Tennessee Gas & Transmission Co. has agreed to supply the required natural gas. The estimated cost of the project is $385,977 to be obtained through issuance and sale of securities.

"Construction of the facilities proposed," the application says, "would fulfill in part the original plan of Tennessee Gas & Transmission Co. to make natural gas available to unserved areas in central and eastern Tennessee. It is proposed to deliver an average of 3,000,000 cu. ft. per day at the city gate of Nashville to Nashville Gas & Heating Co., which now distributes manufactured gas in the city and environs. Additional sales to industries contiguous to the pipe-line system are expected to aggregate at least 4,000,000 cu. ft. per day. "It is the plan of applicant, as soon as materials become available for the purpose, to construct facilities to make natural gas available to other unserved areas in the state of Tennessee, including the cities of Chattanooga and Knoxville," the application continues.

Northern Natural Lays Gas Line Near White Deer, Tex.

To improve facilities Northern Natural Gas Co. is laying 12 miles of 24-in. near White Deer, Tex. The pipe is being coated and wrapped. The job has been contracted by J. R. Stewart Construction Co.



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Phillips to Lay Panhandle Lines

Contracts will be let within a few days for the laying of 25 miles of 22-in. and 12 miles of 12-in. for Phillips Petroleum Co. to transmit natural gas in the Borger-Pampa area of the Texas Panhandle to serve carbon black plants.

Montana-Seattle Line Is Contemplated

Plans for a $15,000,000 project for laying a 1,100-mile 10-in. pipe line from Central Montana to Seattle, have been announced by C. O. Risen of Billings, Mont., vice president of the North Pacific Pipe Line Co., according to reports. The proposed line is to be started early next year.

In addition to the pipe line, the venture would involve construction of a $5,000,000 refinery south of Seattle and a 960,000-bbl. storage farm at Renton.

According to reports surveys and preliminary work have been completed.

Arkansas Pipe Line Buys Caddo Gathering System

Arkansas Pipe Line Corp. has purchased Texas Pipe Line Co.'s crude gathering system in the Caddo pool of North Louisiana. The Arkansas company will increase its runs from 300 to 1,450 bbl. daily through this purchase with the oil going to the Arkansas Fuel Oil Co.'s plant near Shreveport.

Pan American Pumps Through Willacy Line

Construction of the pipe line to transport crude from the Willamar pool of Willacy County to Port Isabel, Tex., for subsequent shipment to refining centers by water, has been completed, E. R. Turner, vice president of Pan American Pipe Line Co. has announced.

Turner added that the first shipment of crude moved by the line had been made by tankship from Port Isabel.

The line is approximately 34 miles long and is constructed of 8⅝-in. seamless-steel pipe, solid welded, and protected from corrosion by asphalt with bonded felt wrapping.

Initial capacity is about 12,000 bbl. daily, which can be increased to the estimated ultimate capacity of the field to produce through the installation of additional pumping units at the field station. Pumping equipment consists of reciprocating pumps and automotive type prime movers.

The line is served by an adequate gathering system and four field gathering stations covering the entire productive area, which is now about 3 miles wide and 5 miles long, in which there are over 50 producing wells, all flowing their allowables.

New Pipe Lines Solve Elk Hills Problems

In connection with the 90 miles of line for several projects authorized to be built by Union Oil Co., The Texas Co. and General Petroleum Co. to provide outlets for the Elk Hills, Calif., field, information has become available to indicate the nature of the problem faced by the Government and the oil companies and some of the factors involved in its solution.

Instead of bidding for the entire 2,500,000 bbl. of crude oil to be produced when offered by the Navy Department, refiners were obliged to keep within limitations of pipe-line transportation. Of the 65,000 bbl. daily to be moved Standard Oil Co. of California had adequate facilities for handling 15,000 bbl. daily but for the remaining 50,000 bbl. daily the 90 miles authorized this month were so imperative that special effort was made to facilitate early construction

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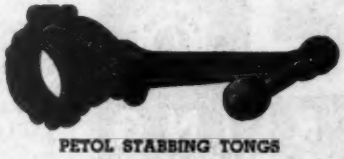
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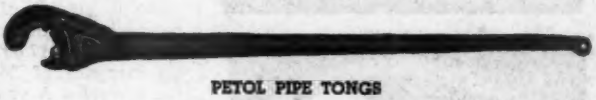
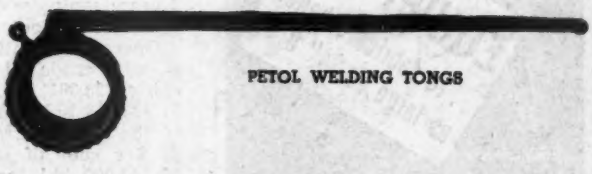
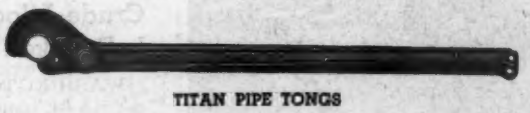

PETOL PIPE TONGS


PETOL WELDING TONGS

TITAN REVERSIBLE CHAIN TONGS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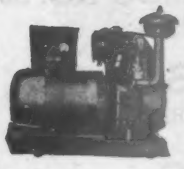

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REFINING

Gulf Coast Gasoline Stocks Continue at Low Level

HOUSTON. — Gasoline stocks at the 11 operating plants of Gulf Coast Refiners Association members continued at their low level in the second half of August, standing at 1,284,400 bbl., an increase of 54,282 bbl. over the figure reported at the close of the first half. A year ago the same refiners reported 1,708,673 bbl. On August 31, 1942, inventories at these plants totaled 2,795,436 bbl., more than twice this year's report.

Automotive stocks considered alone were 425,726 bbl. on August 31, an increase since August 15 of only 12,233 bbl., and representing about 54 per cent of the 763,616 bbl. in storage at this time last year. It represents only 23 per cent of the 1,784,663 bbl. in storage on September 1, 1942, when such a volume was considered about normal.

Total stocks of all products in refineries of the association were reported at 3,447,067 bbl. August 31, an increase of 342,276 bbl. during the 2 weeks. A year ago when crude runs were at a somewhat reduced rate, total stocks were 3,320,632 bbl. Stocks of all products at this time 2 years ago were 6,310,138 bbl., then considered about normal.

Operations continued at high level, with crude oil throughput averaging 123,061 bbl. daily, compared to 123,253 bbl. during the first half of the month. Crude runs were at 88 per cent of operating capacity of 140,000 bbl., an increase of 21,990 bbl. daily, in comparison with operations at 83 per cent of capacity a year ago when the group processed 101,071 bbl. a day. Two years ago in the corresponding period crude runs were 104,000 bbl. daily.

Crude-Allocation Directive Is Revoked by PAW

WASHINGTON. — Petroleum Directive 64, issued March 12, 1943, allocating about 40,500 bbl. of crude oil daily to designated midwestern refiners who might need additional supplies to meet military and essential civilian requirements, has been revoked. "W. W. Vandeveer, the director-in-charge of PAW's Midwest district, has been authorized to issue individual directives, when and if the local crude oil supply situation demands such action," Ralph K. Davies, deputy petroleum administrator, said. "There is, therefore, no further need to carry Directive 64 on the books."

War Orders for Pressure Gages to Be Filled First

WASHINGTON. — The dial pressure-gage industry, which has a backlog of orders totaling $8,500,000, must fill all war contracts before it can fabricate gages for civilian use, the Dial Pressure Gage Industry Advisory Committee has been told by War Production Board officials. However, production of dial pressure gages without priorities is permissible, provided this does not interfere with the filling of rated orders.

Manufacture of pressure gages is still controlled by Limitation Order L-272, which simplifies and standardizes production of this type of instrument, but indications are that it will be revoked after the termination of the war in Europe.

Although the industry must continue to get out all war orders before undertaking production of unrated orders, WPB officials said that with present adequate plant capacity, orders other than those of the Army and Navy may be filled if the materials can be obtained.

Kellogg Completes 3-Year Wartime Program

NEW YORK.—With completion of a refinery installation for The Texas Co. at Wilmington, Calif., The M. W.

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Fabricators and
Contractors
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Products storage
•
Pressure vessels
McNAMAR
BOILER & TANK CO.
Tulsa, Okla. — Salem, Ill.

Kellogg Co., petrochemical engineering organization of New York, has rounded out a 3-year wartime program geared to meet the demand for three vital war products: high-octane gasoline blends for aviation fuels, butadiene for synthetic rubber, and toluene and ammonia for explosives. The undertaking comprised the engineering and construction of more than 50 installations, representing an investment of hundreds of millions of dollars by the oil-refining industry and including 19 fluid catalytic-cracking units for production of aviation gasoline.

The program included the large Cities Service Refining Co. gasoline and synthetic-rubber project at Lake Charles, La., completed last May and transforming a square mile of forest into a busy industrial community.

Kellogg's war program included 25 alkylation and isomerization plants for conversion of gaseous products into aviation alkylate, a constituent of aviation gasoline. To supply butadiene, essential for production of synthetic rubber, the company built three complete butadiene plants.

Constructed for 17 of the principal oil refining companies, most of the units of the war program are located in Louisiana, Texas, Indiana, Illinois, Wyoming, Maryland, California, and Utah. The program also embraced major projects in other countries of the United Nations, including Iran, Canada and the Netherlands West Indies.

Lloydminster Refinery May Become Treating Plant

LLOYDMINSTER, Sask. — Plans are being worked out by a group of producing companies in this area on the Alberta - Saskatchewan boundary for reconstruction of the Lloydminster refinery into a treating plant, utilizing a process which has been operating successfully in the Vermilion field.

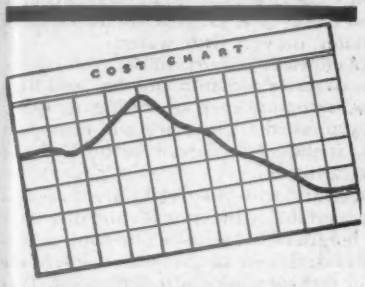
Chemicals of Tomorrow to Come From Petroleum

BARTLESVILLE, Okla. — "Much of the chemistry of tomorrow will be based on petroleum hydrocarbons available in almost endless supply," Frank Phillips, chairman of Phillips Petroleum Co., predicts in the current issue of the company's magazine, Philnews.

"Today, gasoline is not the dominant money product it once was," Phillips points out. "There are also fuel oils, natural gas, synthetic rubber, petroleum chemicals, and many other items, the demands for which hold great postwar promise."

Humble to Sell 20,000 Bbl. Daily to Cities Service

HOUSTON.—Humble Oil & Refining Co. has contracted to sell to Cities Service Oil Co. 20,000 bbl. of oil from the upper Gulf Coast daily during the 5 years beginning September 1. The transaction involves delivery of 36,500,000 bbl. of crude. Cities Service is to pay posted price plus transportation tariffs. The oil will be used by Cities Service Refining Corp. at Lake Charles, La.



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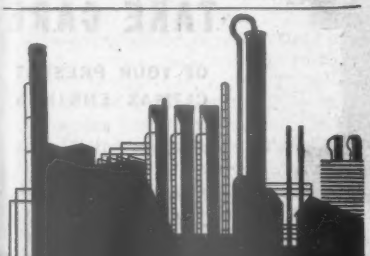

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Climax

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INCREASE POWER DEPENDABILITY . . . LOWER COSTS OF OPERATION

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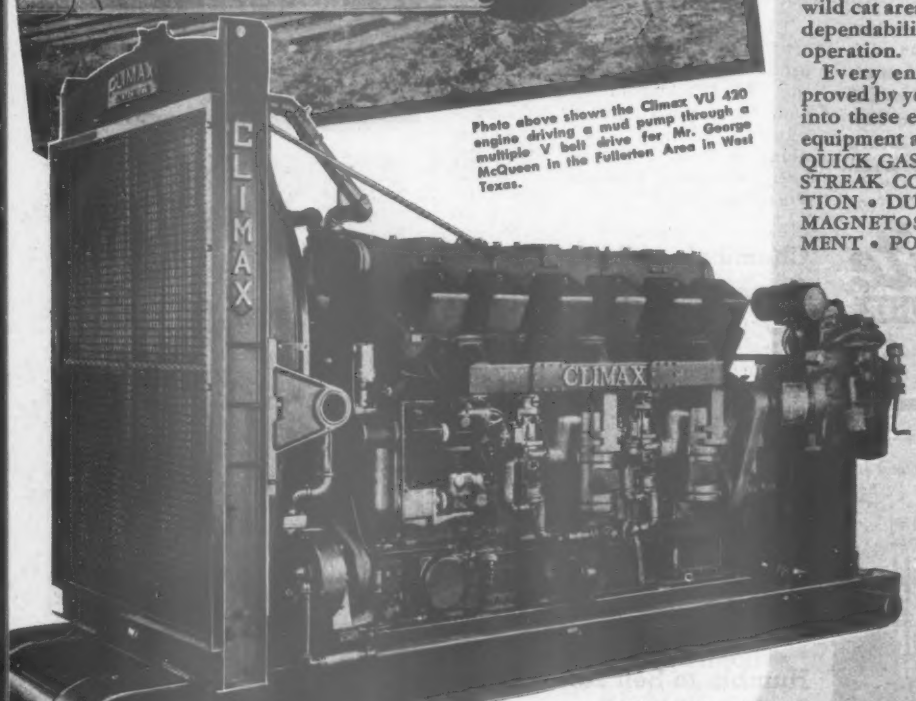
Your Climax engine is famed for its ability to run at low, safe temperatures, in all climates, on very little water.

An unusually large cylinder cooling system, oversize radiator, big fan, and high capacity pump keep operating temperatures uniform. They prevent hot spots and, at the same time, save on fuel and lubricating oil.

Deep and widely spaced water passages surround the cylinder heads and down the full length of the stroke. The cooling system is designed so that water enters the water jackets where heat is greatest. This design feature keeps the combustion chamber and cylinder walls at uniform temperature. The low water demands of your Climax, particularly in impending wild cat areas, greatly increases its power dependability and lowers your costs of operation.

Every engineering design feature, proved by years of oilfield practice is built into these engines. Included as standard equipment are:

QUICK GAS ENGINE STARTING • BLUE STREAK COMBUSTION • DUAL IGNITION • DUAL CARBURETION • DUAL MAGNETOS • TRIPLE FUEL EQUIPMENT • POWER TAKE-OFF & SUPPORT



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1. Keep engine lubricants clean, and maintain oil at proper level. Change oil as directed in instruction book.
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3. Maintain tappet clearances at those shown on engine nameplate. Check with thickness gauge.
4. Keep fuel clean.
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Exploration and Drilling

Week's Highlights

IN these days of calm acceptance of scientific developments as something to be taken as a matter of course, there is a definite tendency to underrate the achievements of the technologists who can only report "steady improvement in instrumentation and techniques, better interpretation as a result of experience." Yet the profit resulting from the "steady improvement" may far surpass the immediate returns from the new discovery.

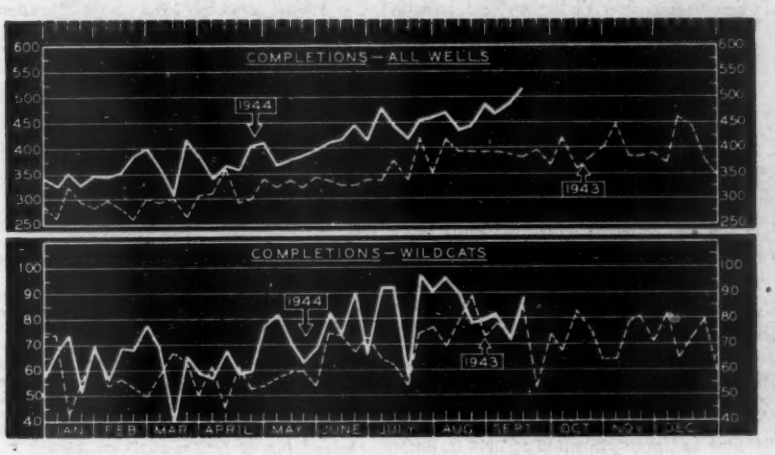
An example of this is presented this week by reports that the deep test in the Haynesville field in Louisiana, in 15-23n-8w, is making 1,000,000 cu. ft. of gas through a ¼-in. choke from the Smackover lime, displaying signs of cleaning itself and may make an oil well.

This well was drilled in 1940, and abandoned as dry at a total depth of 11,270 ft., but was not plugged because, although apparently a failure, the operator was not satisfied. A year later this course was vindicated when Pettit lime production was established in another part of the field. With definite markers and depths to limit the search, the hole was reworked, 9⅝-in. casing set at 5,970 ft., perforated at 5,218-30 ft., and the well was completed for 650 bbl. from the Pettit pay.

Recently in connection with some field joint-operating-committee problems, it was decided to retest the deeper formations, using latest techniques and interpretations to see if pay zones could be found in the Cotton Valley and the Smackover lime formations.

The well was killed in the Pettit pay, 5½-in. casing was set at 11,262 ft., and perforated on basis of 1944 interpretations and instrument techniques. The result is an indication that the Smackover lime probably is productive in Haynesville. Whether the present well will find only gas remains to be determined; and if only gas, then more wells will be drilled to determine whether the present test hit only the gas cap over an oil reservoir, or whether the Smackover contains only gas.

The Cotton Valley, between the Smackover and the Pettit pays, remains to be tested.



Solid line charts current weekly completions

COMPLETIONS IN ALL FIELDS . . .

Week ended September 16, 1944

	Oil	Gas	Dry	Total	Footage	Total Comp. to date 1944	1943
N. Y., Penna., W. Va.*	53	10	5	78	121,316	2,393	2,432
Ohio	5	9	8	22	59,542	697	637
Indiana	1	0	4	5	8,370	163	163
Kentucky	13	0	7	20	36,003	513	285
Illinois	28	0	22	50	125,221	1,303	1,238
Michigan	3	1	8	12	35,225	446	418
Kansas	12	2	17	31	108,503	1,275	1,148
Nebraska, Missouri, Iowa	2	0	2	4	6,478	28	33
Oklahoma	30	2	15	47	187,099	1,236	848
Texas:							
North Central	11	0	14	25	79,811	1,041	1,021
West	27	1	9	37	110,825	1,084	609
Panhandle	7	2	1	10	32,238	173	131
Eastern	1	0	3	4	21,432	226	203
Gulf Coast	21	8	17	46	339,134	873	320
Southwest	2	1	3	6	21,263	498	652
Total Texas	69	12	47	128	604,503	3,895	2,936
Louisiana:							
Northern	3	3	2	8	39,642	220	221
Southern	7	1	2	10	90,553	341	260
Total Louisiana	10	4	4	18	130,195	561	481
Arkansas	2	0	0	2	7,782	156	176
Mississippi	1	0	2	3	15,455	100	59
Southeastern States	1	0	1	2	9,682	32	†
Montana	6	1	2	9	24,275	254	153
Wyoming	4	0	2	6	26,713	119	97
Colorado-Utah	1	0	1	2	12,978	25	18
New Mexico	7	0	2	9	26,567	279	155
California	44	2	4	50	168,559	1,408	936
Total United States	302	43	153	498	1,714,466	14,881	12,213
Total previous week	285	53	151	489			
Total Sept. 18, 1943	200	36	143	379			

*Does not include 40 pressure wells. †Included in total shown for Mississippi.

TEXAS GULF COAST

Harris County Discovery Flowing 300 Bbl. Daily

HOUSTON.—ElTex Ltd. 1 Bender estate, in Mary C. Bulrice Survey, discovery well about ⅛ mile south of Spring in Harris County, is flowing through perforations from 6,244-47 ft. at the rate of approximately 300 bbl. daily on 11/64-in. choke, with tubing pressure of 1,000 lb. and casing pressure of 750 lb. Total depth is 6,249 ft. with 7-in. casing set on bottom. Gravity of the oil is around 38°. No official gage has been made.

Sun Oil Co. 63 John Mitchell estate, South Liberty field, Liberty County, flowed a potential of 163 bbl. daily on ¼-in. choke, with gas-oil ratio of 380 to 1. Tubing pressure was 500 lb., gravity 23.4°, 0.1 per cent water, from 84 perforations at 3,154-75 ft.

The Texas Co. 5 Lillian A. Silliman, in the Ganado field, Jackson County, flowed 205 bbl. daily on ½-in. choke from perforations 6,385-92 ft., gas-oil ratio 650 to 1, tubing pressure 1,000 lb., gravity 35.6°, no water. Total depth is 6,674 ft. with 5½-in. casing set on bottom.

Humble Oil & Refining Co. is reaming to set a string of 5½-in. production casing in the 1 Frank Schmidt, on south flank of Danbury dome, Brazoria County. Total depth is 9,284 ft. A string of 9⅝-in. pipe had been cemented at 7,908 ft. Shows encountered in this test have not been revealed.

Humble 2-B Duncan, wildcat 1½ miles northwest of Spanish Camp gas production, Wharton County, which evidently failed to show anything of interest in perforations from 7,289-95 ft. which were squeezed off after testing, is now testing through perforations at 3,812-22 ft. after setting 2-in. tubing and packer. Total depth is 7,350 ft. with 5½-in. casing set at 7,348 ft.

UPPER GULF COAST WILDCAT COMPLETIONS

Brazoria County: H. C. Cockburn and Salt Dome Oil Co. 1 H. W. Lyman et al unit, Fresno area, J. S. Talmadge Sur., dry at 6,500 ft.

Brazos County: Hamman Oil & Ref. Co. 1 M. W. Sims, Alex de la Garza Sur., 12 mi. W of Bryan, dry at 5,717 ft.

Colorado County: Sinclair Prairie Oil Co. 1 W. H. Kollman, 1½ mi. SE of Freisburg, in P. Piper Sur., dry at 10,761 ft.

Harris County: Tide Water Associated Oil Co. 1 Houston Deepwater Land Co., Deepwater area, Thomas Erle Sur., 4 mi. E of Pasadena, dry at 7,490 ft.

Matagorda County: United North & South Development Co. 1 Buckner Orphans Home, Buckeye area, A. J. Smalley Lge., dry at 8,513 ft.

EASTERN TEXAS

Freestone Wildcat Shows Gas From Woodbine

DALLAS.—Attention of East Texas operators was focused during the past week on The Texas Co. 1 McKnight, projected 8,500-ft. wildcat 3 miles southwest of Fairfield in Freestone County. On a 10-minute drill-stem test at 4,225-31 ft. it showed a steady blow of gas and recovered 30 ft. of drilling mud and 275 ft. of gas-cut water cushion, no salt water. The well resumed drilling after making the test and was believed in the Woodbine sand. With elevation of 458 ft., it had logged top of Austin chalk at 3,510 ft.

Skelly Oil Co. 1 Houston Mills, new gas-distillate discovery in western Panola County about 12 miles west of Carthage, tested about 20,000,000 cu. ft. of wet gas daily from upper Pettit lime at 6,160-85 ft. and was reperforating to test the lower Pettit around 6,350 ft.

Two new 10,000-ft. wildcats were spotted in East Texas last week. In Angelina County, Humble Oil & Refining Co. spotted 1 Angelina County Lumber Co., 550 ft. east and 130 ft. north of the most northerly northwest corner of the W. H. Herring Survey, and in Henderson County about 1 mile east of the Baxter community, Gulf Oil Corp. staked 1 T. D. Frizzell, 1,050 ft. from south, 2,150 ft. from the west lines of the D. Cherry Survey A-135.

Bobby Manziel, discoverer of two Wood County fields, has started another wildcat in that county at 1 V. L. Evans, 800 ft. from north and 1,800 ft. from east lines of the J. Stark Survey.

In the Lone Star area of Cherokee County, W. H. Foster et al 1 Bowling was waiting on orders at total depth 8,355 ft. in Travis Peak sand topped at 8,278 ft. No shows have been reported other than the small gas show encountered in the Rodessa section. In Ellis County, Lasco, Inc., 1 LeSage was reported shut down at 2,837 ft. in Paleozoic rocks topped around 2,520 ft.

EASTERN TEXAS WILDCAT COMPLETIONS

Hunt County: Paul Scott et al 1 B. Woodson, Shelby CSL Sur., A-946, 6 mi. S Caddo Mills, elev. 548 ft., Austin chalk 1,970-2,130 ft., Woodbine 2,588 ft., dry, TD 3,308 ft.

Rusk County: John W. Merritt 1 J. W. Waggoner, Thos. D. Dalby Sur., 1 mi. N Pleasant Grove, elev. 392 ft., dry, TD 3,870 ft.

CALIFORNIA

New Pool Indicated North of Edison Field

LOS ANGELES.—British American Oil Producing Co. and Capital Co. have apparently found a new oil pool a few miles north of the Edison field. Their joint wildcat in 3-30s-29e looked promising on a formation test. This wildcat was drilled to 4,770 ft. and has 7-in. casing cemented at 4,730 ft. On a formation test with packer at 4,715 ft. and a 500-ft. water cushion, gas showed at the surface in 6 minutes, the water cushion in 9 minutes and oil in 12 minutes. The well flowed for 27 minutes at a daily rate of 350 bbl. of 36.2-gravity oil. The well blew for 15 minutes after the packer was pulled loose and the recovery was 450 ft. of 36.2-gravity oil. Between 4,735 ft. and 4,760 ft., 25 ft. of solid oil sand was cored but from 4,760 ft. to 4,770 ft. the formation changed to a shale. It is quite possible the zone found in this well may be upper Olcese and it is quite likely the structure will be a fault trap, a characteristic of this general area.

Standard Oil Co. of California has started work on a projected deep test to be drilled on the Cahn property in the Lost Hills fields. Standard will be joined by General Petroleum Corp., Richfield Oil Corp., Universal Consolidated Oil Co. and Union Oil Co. in sharing the cost of this test. The cost of shutting off an extremely high head water will possibly be the most expensive part of the job unless some mechanical trouble develops with depth. Eight wells have attempted to develop production at Lost Hills without success although one well showed oil that could not be produced because of flowing salt water. Standard's objective at Lost Hills will be the Eocene which has proved productive at Kettleman North Dome to the northwest and North Belridge to the southeast and it is quite probable this may require a 13,000 to 15,000-ft. hole.

Standard of California 20-13 Kern County Land at Coles Levee is down 14,903 ft. and 11-44 Kern County Land in the Greeley field is bottomed at 13,469 ft. in Eocene with a promising oil sand in the bottom of the hole although permeabilities and porosities are reported low. This Greeley Eocene showing indicates the possibility of developing deeper Eocene production in the Rio Bravo field to the north.

Standard's 331-1-C in the Buena Vista

DAILY AVERAGE PRODUCTION FOR WEEK

	Sept. 16 Crude oil	Distillate, allied products	September PAW quota all oils	Sept. 9 crude oil
Arkansas	81,150	4,500	82,900	81,150
California	879,400	51,100	936,700	860,350
Colorado	8,500	.....	8,000	8,700
Eastern	71,800	6,100	81,000	72,600
Illinois	204,800	11,500	222,000	206,600
Indiana	12,500	.....	14,000	14,950
Kansas	280,300	4,300	279,700	254,300
Kentucky	24,600	2,500	27,700	26,500
Louisiana	363,000	35,000	385,000	362,150
North Louisiana	74,600	.....	.....	73,750
South Louisiana	288,400	.....	.....	288,400
Michigan	50,100	400	51,500	49,500
Mississippi	43,600	.....	45,000	46,800
Montana	20,800	200	24,300	20,800
Nebraska	900	.....	1,000	900
New Mexico	105,900	5,500	115,500	105,850
Oklahoma	342,200	27,000	370,800	339,550
Texas	2,156,100	138,000	2,303,000	2,156,050
East Texas	370,900	.....	.....	370,950
East Central Texas	149,850	.....	.....	149,800
North Central Texas	147,800	.....	.....	147,750
Texas Panhandle	98,750	.....	.....	98,700
West Texas	504,150	.....	.....	504,050
South Central (S.A.)	19,300	.....	.....	19,350
South Texas (Laredo)	79,000	.....	.....	79,050
Lower Gulf Coast	243,300	.....	.....	243,350
Upper Gulf Coast	543,050	.....	.....	543,050
Wyoming	96,450	3,000	103,200	86,050
Total United States	4,742,100	289,100	5,051,300	4,696,800
Change from previous week	up 45,300	.....	.....	.....
Total production January 1-September 16, 1944				1,172,067,850 bbl.
Same period last year				1,036,610,750 bbl.

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Hills field where a deeper productive zone is being developed extended the productive limits of the 27-B zone about 1 mile southeast.

In the Coyote field, Barnsdall Oil Co. has cored 181 ft. of oil sand in 2 Sunny Hills at 5,632-6,057 ft. The sand section is interspersed with shale.

CALIFORNIA WILDCAT COMPLETIONS

Fresno County, Ciervo district: Seaboard 54-22 S.P., 22-16s-13e, dry in gray sand, had few minor showings, TD 7,016 ft.

OKLAHOMA

Lincoln County May Get Condensate Pool

SINCLAIR Prairie Oil Co. 1 Danker, SE NW SE 28-14n-3e, in Lincoln County, perforated opposite the Cleveland sand at 3,475-98 ft. and flowed 5 bbl. per hour of 51°-gravity oil or condensate before being shut in for tankage. The well, originally drilled to test the Wilcox at 5,250 ft., has been plagued with troubles, having had a gas blowout in the Oswego, which caught fire and burned the rig.

Carter Oil Co. 1 Johnson, SW SE 30-8n-2w, new Wilcox pool opener in McClain County, is being reworked and a second squeeze job will be made to cut off water, the first squeeze job not being high enough. The well flowed about 100 bbl. per hour through a 3/16-in. choke on test, but showed some salt water, hence the squeeze jobs.

Sinclair Prairie 1 Danahey, NW SE NE 35-8s-2e, near Thackerville in Love County, and northwest of the Walnut Bend pool in Cooke County, Texas, made a drill-stem test at 5,730-80 ft., and recovered 80 ft. of drilling mud with no show, and is now drilling ahead at 5,841 ft.

West Edmond.—Pipe-line runs for the week averaged 26,300 bbl. daily from 139 connected wells, an increase over last week of 1,500 bbl. and 8 wells. Producing wells completed at the end of the week totaled 148, an increase of 9 over last week. One hundred five rigs were operating plus 80 locations announced, including 37 on which derricks were up.

Reports on the last 11 completions in the field indicate an average flow of 98 bbl. per hour on an average test period of 6 hours. The lowest figure was 75 bbl. per hour for 2 hours, the highest 150 bbl. per hour for 4 hours.

OKLAHOMA WILDCAT COMPLETIONS

Garvin County: Ohio 1 Winterrowd, SW SE NE 10-3n-1e, dry, TD 3,606 ft.

Hernstadt 1 Stufflebean, SW SW SE 7-3n-2e, pumped 80 bbl. of 34.7° gravity oil from pay zone 2,991-3,043 ft., TD 3,097 ft. in conglomerate.

Hernstadt 2 Stufflebean, SW SE SW 7-3n-2e, flowed 150 bbl. of 36.5°-gravity oil from pay zone 3,011-30 ft., TD 3,080 ft.

W. A. Delaney, Jr., 1 Burks, NW NW NE 31-4n-3e, dry, TD 3,000 ft.

Greer County: E. M. Thomason 2 Armstrong, NW NW NE 10-6n-21w, dry, TW 328 ft.

Hughes County: Eason et al 1 MacKay, NE NE SE 23-9n-10e, dry, TD 3,300 ft., Cromwell 3,284 ft.

Creekmore-Rooney 1 Panks, SW SW NE 3-8n-10e, dry, TD 3,265 ft., Cromwell 3,206 ft.

Lincoln County: Roy Stephens 1 Hardesty, SE SE NW 20-17n-4e, dry, TD 4,476 ft., Wilcox 4,432 ft., second Wilcox 4,462 ft.

Wilcox et al 1 Sewell, NW NE SE 4-14n-6e, dry, TD 3,250 ft., Verdigris 3,247 ft.

Pawnee County: Continental 1 Morrow, NE SE SE 22-22n-6e, dry, TD 3,362 ft., Arbuckle 3,320 ft.

Stephens County: Magnolia 1 "A" Humphreys, NE SW SW 31-2s-4w, dry, TD 1,210 ft.

Phillips 1 Trout, NW NE NW 19-1n-4w, dry, TD 7,009 ft.

Washita County: Helmerich & Payne 1 Haxton, NE NE NW 31-8n-15w, dry, TD 4,518 ft., granite wash 2,180 ft.

SOUTH LOUISIANA

New Work Declines to Record Low for 1944

NEW ORLEANS. — New work in the South Louisiana district hit a low for the year last week when only five new locations were announced. This compared with 9 the previous week and 24 2 weeks ago. The five new tests were scattered in five parishes and all five are major company operations. Gulf Refining Co. reported one new test, Union Sulphur Co. two, and Shell Oil, Inc., two. There were no wildcats, although Shell located an outpost at Arnaudville field in St. Martin Parish.

A good producer in the Charenton area of St. Mary Parish is Fifteen Oil Co. 6 South Coast Corp. This well was drilled to 7,250 ft. with 7-in. casing set at 6,840 ft. and pipe was perforated from 6,737-40 ft. On potential gage, the well flowed 226 bbl. daily on 9/64-in. choke, gas-oil ratio 290 to 1, tubing pressure 1,075 lb., gravity 37.2°, no water. This is first completion at Charenton in some months.

Humble Oil & Refining Co. 3 Vermilion Parish School Board, in Erath field, Vermilion Parish, was completed through perforations from 7,759-67 ft., flowing 21.6 bbl. in 2 hours on 10/64-in. choke, tubing pressure 600 lb. Total depth is 7,840 ft. with 5½-in. casing set at 7,833 ft. The 2-in. tubing is set at 7,707 ft.

CANADIAN FIELDS

Northwest Turner Valley Gets 2 Good Outpost Wells

CHATHAM.—Two outpost wells now being completed in the extreme northwest of Turner Valley are indicated as good producers. British Dominion 6, LSD 6, 17-21-3w5, finished at 10,238 ft. after drilling two sequences of Madison limestone first contacted at 7,910 ft., made 280 bbl. before acidizing. British Dominion 7, LSD 12, 17-21-3w5, testing Madison at 8,150-8,639 ft. made 350 bbl. after light acid treatment.

In West Central Turner Valley, Okalta 17, LSD 9, 24-19-3w5, testing Madison at 7,388-7,633 ft. made 504 bbl. initial production after acidizing.

Steveville.—In the Steveville field, eastern Alberta, California-Standard 8, LSD 16, 21-20-12w4, finished in lime at 3,983 ft., flowing 45 bbl. per hour of clean oil.

Taber.—Major-Taber 3, LSD 14, 9-9-17w4, finished at 3,245 ft. flowing 300 bbl. dropped to 100 bbl. or less, and will be put on pump.

Turner Valley.—The following recent completions are reported: North Extension, Home-Millarville 16, LSD 9, 18-21-3w5, Madison 8,334-8,746 ft., 901 bbl., 39.4° gravity, with 1,150,000 cu. ft. gas. Home-Millarville 17, LSD 1, 18-21-3w5, Madison 8,330-9,851 ft., 153 bbl. 41° gravity with 464,000 cu. ft. gas. North Central: Royalite Oil 17, LSD 6, 2-20-3w5, Madison 8,290-8,537 ft., 472 bbl., 39° gravity, with 336,000 cu. ft. gas. West Central: Okalta Oils 21, LSD 15, 6-19-2w5, Madison 7,547-7,789 ft., 165 bbl., 41° gravity, with 330,000 cu ft. gas. South: Imperial-Turner Valley 1, LSD 5, 9-18-2w5, Madison 7,102-7,638 ft., 314 bbl. 42.2 gravity with 1,648,000 cu. ft of gas.

OHIO, KENTUCKY

Clinton Gas Discovery Reported in Wayne County

COLUMBUS.—Northern Ordnance's wildcat, 1 Mary Martin, Section 3, Green Township, Wayne County, came in as a fair gas well. Clinton sand at 3,440-48 ft. gaged 360,000 cu. ft., second sand at 3,493 to 3,506 ft., was dry. Sand was shot and had an estimated shut-in gage of 500,000 cu. ft. with rock pressure of 1,130 lb.

The East Bloom pool was extended a location to the south by Palm Oil Co. 1 Worley Greer, Section 15, Bloom Township, Morgan County. Clinton at 4,391 to 4,429 ft. gaged 940,000 cu. ft. with a rock of 820 lb.

The Wheeling Oriskany pool was extended ½ mile south by Ohio Fuel Gas Co. 1 C. H. Gibson, Section 6, Liberty Township, Guernsey County. Sand at 3,539-45 ft. gaged 979,000 cu. ft.

Sinclair Prairie Oil Co.'s Oriskany test in Washington County reached the sand at 5,121 ft. and is drilling ahead without shows.

OHIO WILDCAT COMPLETIONS

Ashland County, Troy Township: Frank Brendel 1 John Davidson, Lot 10, Clinton 2,523-26 ft., dry, TD 2,625 ft.

Geauga County, Auburn Township: Ohio Fuel 1 A. C. Brewster, Lot 5, Clinton 3,857-3,908 ft., 3,911-23 ft., and 3,936-41 ft., dry, TD 4,544 ft.

Wayne County, Green Township: Northern Ordnance 1 Mary Martin, Sec. 3, Clinton 3,440-48 ft., 500,000 cu. ft. of gas, Clinton 3,493-3,506 ft., dry, TD 3,515 ft.

WESTERN KENTUCKY

OWENSBORO.—In the recently opened Powell Lake pool, about 5 miles north of Uniontown, in Union County, Gulf Refining Co. 3 Rankin, ni 16-Q-20, swabbed 192 bbl. per day from Waltersburg sand at 1,813-19 ft., the total depth. The Pennsylvanian sand also pays in this pool at around 1,186-1,215 ft., with two wells that made 85 bbl. per day production initially.

Eighteen wells were reported completed during the week in western Kentucky, 11 oil wells, with an average per well production of 122 bbl. per day, and 7 dry holes.

WESTERN KENTUCKY WILDCAT COMPLETIONS

Henderson County: Delta Drilling 1 Mrs. W. H. Cabell, 3-P-21, pumped 45 bbl. per day from Pennsylvanian sand at 1,502-14 ft., TD 1,516 ft.

Sohio 1 Walker, SW NW SW 5-N-25, dry at 2,615 ft., Glen Dean 1,816 ft., Barlow 2,275 ft., Renault 2,272 ft., McClosky 2,510 ft.

Ashland 1 R. S. Jennings, 12-O-25, 3 mi. NE of Niagara, dry at 2,354 ft., Vienna 1,556 ft., Glen Dean 1,675 ft., Barlow 1,929 ft., Ste. Genevieve 2,140 ft.

Union County: Texas 1 Scott, 12-O-20, 3 mi. E of Morganfield, dry at 2,796 ft., Menard 1,703 ft., Benoist 2,438 ft., Ste. Genevieve 2,542 ft., St. Louis 2,770 ft.

EASTERN KENTUCKY

ASHLAND. — Elliott County reported completion of two small oil wells during the week. A midmonth roundup lifted

total completions to 24, including a completed log for a 20-bbl. well and 20 gas-well completions.

Eastern Kentucky's natural-gas output was boosted by a combined daily open flow of 10,658,000 cu. ft. of gas with a total footage for the oil and gas operations of 63,698. Three of the gas wells were outstanding producers according to initial reports.

The various reports show a slight upturn in activities with the number of completions running slightly ahead of the same period in August.

INDIANA

EVANSVILLE. — A wildcat in Pike County started off as a small producer, and another, but incomplete wildcat, in Gibson County, Savage and Fleming 1 Adam Dawson, SW SE NE 25-3s-12w, flowed oil naturally in a drill-stem test of Levias lime at 2,510-21 ft., the total depth. Five wells were completed during the week in Indiana but 4 of these were dry.

INDIANA WILDCAT COMPLETIONS

Pike County: H. C. Detrick 1 Knick, SE NW NW 8-1s-7w, Cypress sand 1,135-39 ft., TD, pumped 12 bbl. in 24 hours.

SOUTHWEST TEXAS

Condensate Producer Hit Near Cabeza Creek Area

CORPUS CHRISTI.—Continental Oil Co. 1 Victoria Albrecht et al, gas-condensate discovery well in Manuel Carriona Survey, 3⅝ miles south of Cabeza Creek Wilcox discovery, is reported completed through 48 perforations at 8,340-60 ft. It flowed 45 bbl. of 58.8° gravity condensate in 14 hours through ¼-in. choke. Tubing pressure was 2,475 lb., casing pressure 125 lb., and gas-oil ratio was 79,011 to 1. Another gage showed flow of 2 bbl. per hour on ⅛-in. choke, against tubing pressure of 2,675 lb. Open flow on the gas is estimated at 14,500,000 cu. ft. daily. Shut-in tubing pressure is 2,910 lb.

Phillips Petroleum Co. 1 Mrs. Olga Stuermer (Kraeger), Slick-Wilcox area, Goliad County, was completed as a gas well in 92 perforations from 7,529-52 ft., estimated 2,000,000 cu. ft. gas daily on 5/32-in. choke, and shut in. Flowing pressures were 1,800 lb. on tubing and 2,100 lb. on casing. Total depth is 7,644 ft.

Amerada Petroleum Corp. 1 Waitschies, wildcat 12 miles northeast of Goliad in Goliad County, perforated around 12,000 ft. and tested dry gas. The Yegua sand near 9,520 ft. is reported to have flowed 42-gravity oil and mud, no water, with 1,820 lb. pressure. Operators will drill out and test lower pays.

New producer for the Tijerina field of Jim Wells County is The Texas Co. 5 H. C. de Tijerina, completed at total depth 7,170 ft., with 5½-in. casing set on bottom. Pipe was perforated from 7,126-32 ft., and the well flowed a potential of 252 bbl. daily on ½-in. choke against pressures of 910 lb. on tubing and 1,920 lb. on casing. Gravity was 40.5° and gas-oil ratio was 1,125 to 1.

Phillips 1 Mrs. S. E. Radford, in Hondo Creek, Karnes County, flowed 112.8 bbl. daily on ½-in. choke from 60 perforations at 6,586-98 ft. Pressures were 1,550 lb. on tubing and 2,100 lb. on casing. Total depth is 6,650 ft., with 5½-in. casing on bottom.

Henderson Coquat 3 Reagan, wildcat about a mile south of Oakville, in Live Oak County, was perforated at 6,771-73 ft. and operator is running drill-stem test. Test at 6,772-76 ft., prior to setting casing, recovered oil and some salt water. This wildcat also had gas-condensate on test at 6,940-47 ft. and oil and some salt water on test at 6,956-57 ft.

Edwin M. Jones 4-C Harry Ezzell, agent, southwest of the 2-C Ezzell, discovery well at San Caja field, McMullen County, topped gas sand at 6,458 ft., ran drill-stem test from 6,469-77 ft., developed 620 lb. pressure in 30 minutes flowing through ¼-in. choke, and recovered 60 ft. of condensate-cut mud, and 120 ft. of brackish water. Operators are now drilling ahead to test deeper sand.

SOUTHWEST TEXAS WILDCAT COMPLETIONS

Bastrop County: Sohio Oil Co. 1 R. H. Andrews, Sec. 12, Kerr Sur., 15 mi. S of Bastrop, dry at 3,540 ft. in sidetracked hole.

Nueces County: Cities Service Oil Co. 1 H. J. Mattiza, Geo. H. Paul subd. of Driscoll ranch, 1 mi. W of Robstown, dry at 8,000 ft.

San Patricio County: Rogers Bros. Drlg. Co. 1 T. A. McKamey, Juan Armendaris Sur., 3 mi. W of White Point gas field, dry at 7,200 ft.

Victoria County: Northern Ordnance 1 H. M. Rushhaupt, 1 mi. N of Mission Valley, Eben Haben Sur., dry at 9,242 ft.

Victoria County: Sinclair Prairie Oil Co. 1 M. E. McCampbell, 2 mi. N of Keeran field, A. Nelson grant, Abst. 63 and O'Connor & Allen Sur., Abst. 505, dry at 8,012 ft.

Zavala County: The Texas Co. 1 C. Van Cleve, GC&SF Sur., 12¼ mi. NW of Crystal City, dry at 2,370 ft.

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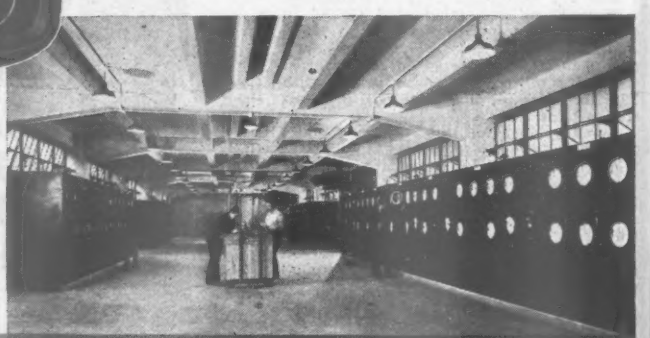
2. **Hyper-Reset values** are adjusted, when necessary, at the valve manifold above the Proportional Band control. Adjustment is not critical, and the factory setting of these valves will usually be satisfactory.

Only Foxboro offers a single adjustment on this type of instrument, because only Foxboro *combines* the *reset or floating action* with the *rate sensitive action*. Thus the Model 30 Stabilog Controller is extremely simple to put into operation. Yet, there's no sacrifice whatever in accuracy, flexibility, or performance.

This panel containing many Model 30 Stabileg Controllers in a leading chemical plant is typical of the chemical processing industry's reliance on Foxboro Instrumentation that creates and applies automatic instruments to improve production and reduce costs.



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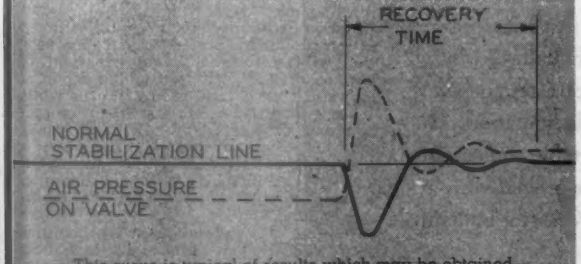
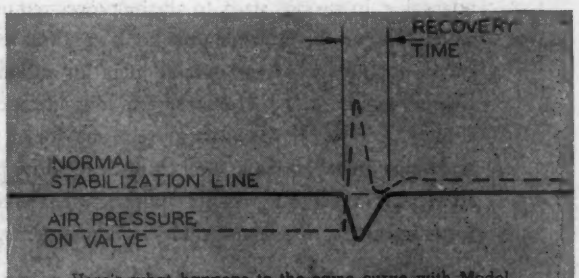
As a case in point, the *Foxboro Hyper-Reset Stabilog Controller* has brought to air-operated control a degree of high performance that has never been approached. Operating on a principle entirely different from previous standard controllers, this remarkable instrument "feels" the rate of change of disturbance at the very start. Corrective action, measured and of the proper magnitude for any adjustment or disturbance, is instantly in effect. The result is smoother and faster recovery from any process disturbance. Under average process conditions, recovery is often effected *in as little as one-fourth the usual time – with as much as 50 per cent reduction in the amount of upset.*

In appearance as well as action, too, the Model 30 Stabilog Controller reflects the advanced thinking of Foxboro Instrumentation. Its trim, rectangular housing "squares the circle" for compactness, high visibility, and broad utility. Its modern design permits true flush mounting for maximum efficiency and safety.

For complete details, write for illustrated Bulletin A-330. **The Foxboro Company, 60 Neponset Ave., Foxboro, Mass. Branches in principal cities.**



This curve is typical of results which may be obtained from efficient proportional control with reset before the development of HYPER-RESET. Note the period required for recovery from this typical upset.



Here's what happens to the same curve with Model 30 Stabilog Controll. With HYPER-RESET added to Proportional Control, stabilization is often achieved in ¼ the time, upset reduced as much as 50 per cent.

Stabilog Controller...

REG. U.S. PAT. OFF.

PERMIAN BASIN

New Locations Focus Interest on Wildcatting

MIDLAND.—The Texas Co. boosted its wildcatting program in West Texas last week with the staking of three new tests, one each in Lynn, Yoakum and Tom Green counties. The company's 1 C. O. Edwards & Sons was spotted in the southeast corner of Section 158, Georgetown Railway Survey, 10 miles northwest of Tahoka, Lynn County, and was contracted to 6,500 ft. The 100-A Miller was staked 2,200 ft. from south and east lines of Section 861, Yoakum County, as a 7,500-ft. test in the Wasson pool, where regular production is from the 5,000-ft. level. This new deep operation is about 4 miles northwest of the Wasson deep pay production opened up by Amon Carter. In Tom Green County, The Texas Co. is starting 1 Gorman as a 5,500-ft. Ellenburger wildcat in the NW Section 85, Block 11, SPRR Survey, 7 miles southeast of San Angelo, and on an 11,000-acre block.

Ward County.—Gulf Oil Corp. B-2 Edwards, seeking to open Tubb pay production 2½ miles southeast of Monahans, recovered 120 ft. of mud and about 1 pt. of free oil on a drill-stem test from 4,488 to 4,580 ft., in the Tubb zone, and was coring ahead.

Andrews County. — Champlin Refining Co. 1-B University, wildcat 5 miles northwest of the Embar field, in Section 5, Block 11, had oil stains in samples from 8,154-56 ft. and was drilling ahead. Top of Ellenburger was tentatively called at 8,138 ft. with tentative base of Permian at 8,039 ft. It has logged a number of oil shows in the lower Permian. Stanolind 1-D University, wildcat 1¼ miles south of the Champlin test, showed a steady blow of gas on a drill-stem test at 8,037-76 ft. and was coring ahead, probably in the Ellenburger. Unofficial reports indicate that it topped the Ellenburger at 8,046 ft., with very little, if any, Simpson present.

Pecos County. — Standard Oil Co. of Texas 1-A Mac Der Co., recent Wolfcamp pay discovery 8 miles southeast of Owego, was completed flowing 94 bbl. of oil in 24 hours from perforations at 4,900-60 ft. and 4,881-86 ft., but production declined next day to 24 bbl. and it is being reacidized. Humble Oil & Refining Co. 1 El Paso National Bank, another recent discovery, in Section 7, Block 140, T&StL Survey, also believed production from the Wolfcamp, also failed to maintain satisfactory production and has resumed drilling at 5,463 ft. on its original 6,500-ft. contract. A new 3,500-ft. wildcat, 7 miles southeast of Fort Stockton, has been staked by General Crude Oil Co. of Houston, for 1 H. L. Winfield, 2,310 ft. from west, 320 ft. from north lines of Section 2, Block 132, T&StL Survey.

WEST TEXAS WILDCAT COMPLETIONS

Crane County: Texas Co. 1-B C. W. Hobbs, Sec. 41, Blk. 35, H&TC Sur., 5 mi. W McCamey, elev. 2,391 ft., Yates 1,140 ft., San Andres 2,130 ft., Devonian 5,325 ft., top pay 5,331 ft., flowed 131 bbl. day through 14/64 on 2-in. tubing, gas-oil ratio 1,930 to 1, gravity 43.9°, TD 5,391 ft.

Dawson County: Stanolind Oil & Gas 1 C. T. Locke, Tr., Sec. 96, Blk. M, EL&RR Sur., 15 mi. W Lamesa, Yates 2,950 ft., San Andres 4,570 ft., dry, TD 5,122 ft.

Gaines County: Stanolind Oil & Gas 1 T. S. Riley, Sec. 11, Blk. H, D&WRR Sur., elev. 3,181 ft., anhydrite 2,106 ft., Yates 3,200 ft., brown lime 4,180 ft., dry, TD 5,276 ft.

Howard County: John B. Hawley, Jr., 2 Guitar Est., Sec. 18, Blk. A, Bauer & Cockrell Sur., elev. 2,539 ft., dry in San Andres, TD 3,302 ft.

PANHANDLE WILDCAT COMPLETIONS

Moore County: Jennie Rubin 1 Brown, Sec. 4, Blk. 2, G&M Sur., 4½ mi. SW Balitista, IP 45,000,000 cu. ft. gas day, nat., TD 3,424 ft.

SOUTHEASTERN NEW MEXICO

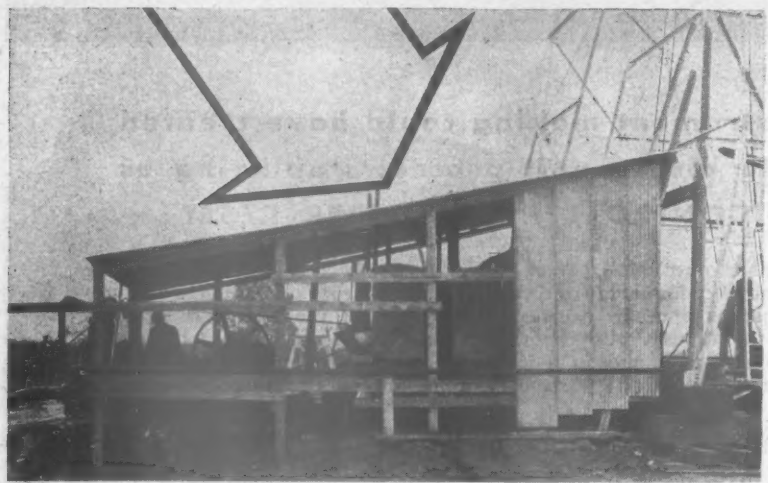
HOBBS.—Shows of oil and gas from below 11,000 ft. have been reported by Humble Oil & Refining Co. 1 Federal-Leonard Oil Co., deep wildcat in 12-26-37, southeastern Lea County, about 7½ miles north of Magnolia 20 State-Walton, discovery well in the Kermit-Ellenburger field of Winkler County, Texas. Humble reported shows of both oil and gas in returns while drilling at 11,712 ft. in the Simpson section and at total depth 11,716 ft. made four unsuccessful attempts to make a drill-stem test. It was drilling ahead below 11,734 ft. in sandy shale and dolomite, apparently still above top of the Ellenburger lime.

Humble 1 Federal-Keinath, another deep wildcat east of Eunice, in 8-21-38, also logged a show of oil during the week. On a drill-stem test at 7,465 to 7,524 ft., open 50 minutes, a small quantity of free oil was recovered on top of water blanket, with a slight show of gas. Operator cored ahead at 7,567 ft.

SOUTHEASTERN NEW MEXICO WILDCAT COMPLETIONS

Eddy County: R. E. McKee and C. N. Bassett 1 Brainard, 34-18s-29e, elev. 3,617 ft., top pay 2,110 ft., pumped 15 bbl. day, TD 2,265 ft.

Childress Royalty Co. 1 Brown-State, 32-20s-26e, elev. 3,319 ft., dry, TD 2,550 ft.



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N. CENTRAL TEXAS

Simpson Sand Shows for Producer in Bowie County

WICHITA FALLS.—Probable opening of oil production from the Simpson sand in southwestern Bowie County was forecast last week as Continental Oil Co. 1 J. R. McNutt, wildcat 2½ miles southwest of Bowie and in the Burnett-McNutt Survey, drilled sand showing oil at 7,003-13 ft., then made a 45-minute drill-stem test at 7,005-13 ft. and recovered 100 ft. of clean oil and 20 ft. of drilling mud, showing 2,950 lb. bottom-hole pressure. It drilled ahead, logging top of Ellenburger at 7,102 ft., and was last reported drilling at 7,166 ft. in dry lime. Previously, it had recovered 300 ft. of oil and 30 ft. of salt water on a drill-stem test in the Viola lime section at 6,744-56 ft. Top of dolomite, probably the Simpson, was established at 6,883 ft.

Throckmorton County's new Caddo lime discovery, Panhandle Refining Co. et al 1 Ewalt, 7 miles east of Throckmorton, in Section 2170, TE&L Survey, perforated pipe at 4,156-61 ft., used 1,000 gal. of acid, then flowed 200 bbl. of oil in 2½ hours, making 50 bbl. during the second hour through a ½-in. choke, and was then shut in for storage. The hole had been drilled to 5,034 ft. in dolomite and was plugged back to 4,500 ft. before completing.

Cooke County.—Kadane-Griffith Oil Co. 1 S. B. Hopkins, new discovery reported last week, was drilling plugs to complete. At total depth 2,983 ft., with sandy conglomerate pay between 2,970-83 ft., it made a 30-minute drill-stem test at 2,978-83 ft., showing gas in 5 minutes and recovered 1,800 ft. of oil and 90 ft. of oil-cut mud, then cemented 7-in. casing at 2,969 ft. A north offset location has been staked by Paul B. Scott for 2 Walterscheid, 330 ft. out of southeast corner of the E. Langford Survey A-566, which also is 660 ft. due south of Paul Scott 1 Walterscheid, a 2,610-ft. sand producer. A deep wildcat in northern Cooke, The Texas Co. 1 Rasure, Sivels Bend prospect, has cemented in string of 7-in. pipe at 6,805 ft. after plugging back to 6,810 ft. from total depth of 7,518 ft. in shale. It will perforate pipe to test sand around 6,759-75 ft., which yielded oil on a drill-stem test several weeks ago.

WEST CENTRAL TEXAS WILDCAT COMPLETIONS

Jones County: Merry Bros. & Perini and Alder Oil Co. 1 J. N. Herndon, Sec. 19, Blk. 2, SPRR Sur., 3 mi. N Truby, elev. 1,731 ft., top pay 2,382 ft. in Flippen lime, pumped 258 bbl. day through 2-in. tubing, gravity 38°, TD 2,388 ft.

Shackelford County: Chas. S. Miller et al 1 J. F. Dyer, Sec. 94, Blk. 12, T&P Sur., 12 mi. SW Sedgwick, elev. 1,631 ft., dry, TD 1,265 ft.

Stephens County: W. F. Lacey et al 1 B. J. Joe, Sec. 448, SPRR Sur., 1 mi. SE Gunsite, elev. 1,441 ft., Strawn sand slight show gas 1,680-88 ft., dry, TD 1,798 ft.

W. F. Lacey et al 1 Mrs. M. C. Taylor, Sec. 29, Blk. 7, T&P Sur., 3 mi. N Leeray, elev. 1,419 ft., top pay 1,879 ft. in Strawn sand, flowed 7 bbl. day through open 2-in. tubing, TP 22 lb., gravity 41°, TD 1,822 ft.

NORTH CENTRAL TEXAS WILDCAT COMPLETIONS

Archer County: Fortex Oil Co. 1 Mattie H. Ingersoll, Sec. 1, SPRR Sur., A-434, 6½ mi. S and 1½ mi. W Mankins, elev. 1,144 ft., dry, TD 1,710 ft.

King & Petre 1 E. R. Treet, S. J. Williams Sur., A-786, 3 mi. S and 2½ mi. E Archer City, elev. 1,021 ft., dry, TD 1,159 ft.

Clay County: Continental Oil Co. and Edge Oil Co. 1 W. D. Crockett, Sec. 3245, TE&L Sur., 4 mi. W Vashti, elev. 1,081 ft., Caddo 5,768 ft., Mississippian 6,483 ft., top pay 6,503 ft., PB to 6,561 ft., pumped 167 bbl. day, gravity 41°, TD 6,817 ft.

C. H. Featherstone 1 A. H. Bevering, BBB&C Sur., A-367, 2 mi. SE Charlie, elev. 944 ft., dry, TD 1,400 ft.

Cooke County: Trumpter Petroleum Co. 1 J. B. Pace, Thos. Cook Sur., A-258, 1 mi. NE Era, Ellenburger 1,495 ft., dry, TD 1,551 ft.

Montague County: Glenn Grimes & Joe Schmidt 1 W. S. Barcus, Blk. 78, Kaufman CSL Sur., 6 mi. N Bonita, elev. 916 ft., granite 4,478 ft., dry, TD 4,480 ft.

Wichita County: Akin & Dimock 1 R. E. Gibson, Lot 271, Waggoner Colony subd., 3 mi. N and 2 mi. E Electra, elev. 1,131 ft., dry, TD 2,101 ft.

ROCKY MOUNTAIN

10,000 Ft. Wildcat Test For Southwest Wyoming

DENVER.—A 10,000-ft. wildcat will be drilled this fall by the Mountain Fuel Supply Co. in southwestern Wyoming on the Church Buttes structure 60 miles west of the Baxter Basin gas fields and near the boundary line where Unita, Lincoln and Sweetwater counties come together. It is expected that 6,000 to 7,000 ft. of Tertiary will be drilled and that to the final objectives will be between 10,000 and 11,000 ft. The Wasatch formation of Tertiary age is productive at Powder Wash in 12n-97w and Hiawatha in 12n-100w.

The Stanolind Oil & Gas Co. has three large blocks in Sweetwater County comprising 197,000 acres, one of which lies adjacent to the Mountain Fuel Supply Co. block on the north and east. Stanolind has been doing extensive shooting throughout the area.

Sinclair to test Dubois area.—Sinclair-Wyoming Oil Co. has released location for a wildcat in the Dubois area, northwest corner of Fremont County, Wyoming, in NE NE NE 11-42n-107w, which will explore new territory. It lies south of the Owl Mountain range, which forms the southern boundary of the Big Horn basin, and on the Wind River uplift along which to the southeast are the Maverick Springs, Pilot Butte Steamboat Butte and other producing fields.

McElmo test in salt beds.—Stanolind Oil & Gas Co. 1 Government, C SW NW 24-36n-18w, McElmo structure, Montezuma County, southwestern Colorado, drilled into the Paradox salt formation at 4,755 ft. and is drilling ahead in salt at 6,027 ft. The McElmo well had several shows of gas and high-gravity oil above the Paradox salt. It had the top of Shinarump at 1,450 ft.; the Cutler at 1,899 ft.; and the Hermosa at 3,495 ft. The best show of gas, 3,000,000 cu. ft., was just above the top of the salt.

Craig wildcat to resume.—Republic Oil Co. 1 Eberle, SE SE SW 9-6n-91w, Craig structure, Moffat County, Colo., which temporarily suspended drilling at 1,919 ft., is moving in heavy duty rotary from California and expects to resume drilling soon.

Weber test at Wilson Creek.—Texas Co.-California Co. 20 Unit, NE SW NE 34-3n-94w, Wilson Creek field, Colorado, is drilling a large hole and will carry the 9⅝-in. through the Sundance, the lowest horizon so far tested in that field. This will leave a hole of sufficient size to continue on down to the Weber (Pennsylvanian) which is the producing horizon at Range-

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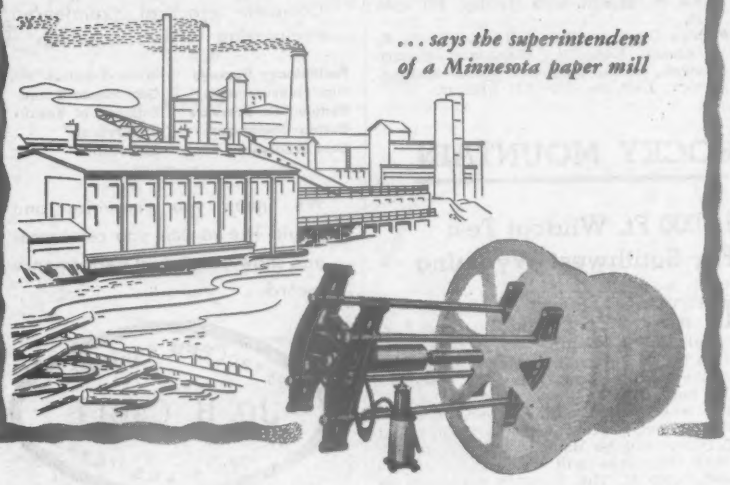

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ly, 50 miles to the west, where the Weber is found around 1,500 ft. below the top of the Sundance.

COLORADO WILDCAT COMPLETIONS

Larimer County, Sand Creek: Amerada 1 Rorabacher, SW SW 32-11n-68w, TD 6,956 ft., top Dakota 6,846 ft., dry, will move rig 12 mi. NE for another wildcat.

WYOMING WILDCAT COMPLETIONS

Hot Springs County, Gebo: Continental 3 Gebo unit, SW SE NW 23-44n-95w, TD 5,103 ft., top Tensleep 4,887 ft., 7-in. 5,098 ft., flowed 1,309 bbl. in 24 hours, discovery in deeper pay.

Fremont County, Little Dome: Superior 2 Little Dome, NW SE SE 10-5n-1w, TD 4,150 ft., in Chugwater, dry.

Sweetwater-Fremont counties, Lost Soldier: Sinclair-Wyoming 1 Tropic, SE SW SW 34-27n-90w, TD 4,948 ft., top Dakota 4,918 ft., dry.

MONTANA WILDCAT COMPLETIONS

Toole County, Dunkirk area: Hannah-Porter Co. 1, Skinner, SE NW NE 20-32n-1w, TD 1,426 ft., 7-in. 1,410 ft., Sunburst 1,410-25 ft., 2,850,000 cu. ft. gas.

Teton County, South Pendroy Block: Texas 1 Rowland, SE NE SE 31-27n-5w, TD 2,436 ft., Ellis-Madison 2,391 ft., shot 60 qt. at 2,391-2,404 ft., water, dry.

MICHIGAN

Shell to Acidize New Discovery in Tuscola

SAGINAW.—Shell Oil Co., Inc., planned to acidize its 1 Woichan test in Novesta Township, Tuscola County, after getting a show of oil. The show was around 3,000 ft. in Monroe formation and the test was continued to nearly 4,000 ft. where Sylvania rock of unusual hardness slowed the rotary. The test is the outgrowth of extensive seismograph prospecting and Shell was reported planning several other tests in the Thumb area as a result of its findings.

More extensive development of the Goodwell gas pool, Newaygo County, is in store after the third producer rated at more than 10,000,000 cu. ft. in 2 weeks. Michigan Consolidated Gas Co. took out four new drilling permits for wells in that area.

Gulf Refining Co. reported abandoning 1 Salina deep test in Bay County's Kawkawlin field, announcing the exploration was continued to a depth of 7,976 ft.

MICHIGAN WILDCAT OPERATIONS

Allegan County, Hopkins Township: Oil Producers 1 Wamhoff, SW SW SE 17-3n-12w, dry in Traverse limestone, TD 1,597 ft.

Monterey Township: Muskegon Development 1 Todd, NE NE SE 20-3n-13w, 5 bbl. and salt water, acidized, Traverse limestone formation, TD 1,841 ft.

Grimes & Sons 1 Commans, SE SE NE 28-3n-13w, dry in Traverse limestone, TD 1,787 ft.

Arenac County, Whitney Township: Sun 1 Tolgo, NE SE NE 16-20n-7e, dry in Dundee formation, TD 3,462 ft.

Lapeer County, Rich Township: Mammoth Producing 1 Welke, W½ SW NW 21-10n-10e, dry in Sylvania formation, TD 3,315 ft.

Mecosta County, Big Rapids Township: W. C. Taggart 1 Taggart et al, W½ SE SW 11-15n-10w, dry in Detroit River formation, TD 3,466 ft.

APPALACHIAN FIELD

Trenton Lime Test Reaches Record Depth

PITTSBURGH.—Except for the test now drilling through the Trenton lime in Butler County, Pennsylvania, at record depth in the Appalachian of 9,652 ft., none of the Oriskany wildcats have reached producing horizons. In Cross Creek Township, Washington County, Pennsylvania. The Texas Co. started drilling a Clinton sand test.

In Fayette County, Pennsylvania, Peoples Natural Gas Co. completed 2 Joseph Baer in German Township as a gas well gaging 1,700,000 cu. ft. from the Gantz sand, total depth 2,237 ft. and rock pressure of 505 lb. In Greene County, Lewis, Pettit et al halted their 1 Anna Maletta in the Salt sand at 1,359 ft. with a gage of 438,000 cu. ft. of gas at 1,340 ft.

In West Virginia, O. H. Reed completed 1 P. G. Deweese in Washington district, Calhoun County, for 3,000,000 cu. ft. gas from the Big lime topped at 1,900 ft. and drilled to total depth 1,840 ft.

John T. Galey abandoned the Oriskany wildcat at Tomlinson Run Park (H. Balser) fee, Hancock County, as dry when about 250 ft. of salt water intruded at 4,619 ft.

In Lincoln County, Dotson Bros. Gas Co. completed a test on Huntington Development & Gas Co. fee in Laurel Hill district in the Brown shale which gaged 900,000 cu. ft.

In DeKalb district, Gilmer County, there was an 8-bbl. well; in Lincoln district, Wayne County, a 3-bbl. well, and in Union district, Wood County, a 5-bbl. well.

ILLINOIS

Concord Pool Extended by Phillips Petroleum Co.

MATTOON, Ill.—Phillips Petroleum Co., which completed an 800-bbl. well in its 4 Tuley in the Concord pool in White County, reported last week, has another good one in prospect in No. 5 Tuley, northwest offset to No. 4, and located in SW NE NE 21-6s-10e. Producing from McClosky lime at 2,979-85 ft. in a drill-stem test it flowed clean oil in 30 minutes. It extends the pool northerly.

Fifty wells were completed in the state during the week, of which 28 were oil wells with a total initial output of 3,078 bbl., and 22 were dry holes. Forty-four new operations were reported only four of which were wildcats, namely, Olds Oil 1 J. L. Smith, NE SE NE 17-2n-12w, Lawrence County; Gilliam and J. W. Carter 1, farm name not given, SW SE SE 14-4s-9e, White County; J. E. Carlson 1 Gehl, SE NE SW 32-11n-14w, Clark County, and Sohio Petroleum 1 E. Townsend, SW SW NW 7-5n-13w, Crawford County.

ILLINOIS WILDCAT OPERATIONS

Effingham County: Bander & Shaffer 1 MacSmith, SW SW NE 33-9n-5e, dry at 2,252 ft. Glen Dean 1,805 ft., Cypress 1,978 ft., Benoist 2,085 ft., Aux Vases 2,132 ft., McClosky 2,232 ft.

Fayette County: Nation Oil 1 Ed Smith, SW SE SE 14-6n-3e, dry at 2,225 ft. Glen Dean 1,676 ft., Cypress 1,809 ft., Benoist 1,992 ft., Aux Vases 2,060 ft., McClosky 2,206 ft.

Franklin County: H. R. Randall 1 U. S. C. & C. Co., NW NW SW 14-5s-2e. pumped 42 bbl. from Aux Vases sand at 2,679-2,711 ft., TD 2,716 ft. Discovery well.

Cumberland County: Fogle et al 1 Arthur Brown, SW NE SE 1-9n-10e, dry at 1,010 ft. No log available.

Hamilton County: Ohio Oil 7 Moore, NE NE SW 36-6s-5e, dry at 3,498 ft. Degonia 2,095 ft., Cypress 2,926 ft., Aux Vases 3,185 ft., McClosky 3,357 ft.

Hardin County: Northern Ordnance 1 Fricke, SW SE SE 30-11s-8e, dry at 3,306 ft. Devonian-Silurian 100 ft., Maquoketa 1,775 ft., Kimswick 2,124 ft., Joachim 2,805 ft., St. Peter 3,120 ft., Prairie du Chien 3,207 ft.

Jasper County: Magnolia 1 Iffert, NE NE SE 27-5n-8e, dry at 3,167 ft., Upper Kincaid 2,100 ft., Cypress 2,694 ft., Benoist sand 2,857 ft., Aux Vases 2,931 ft., McClosky 3,095 ft., St. Louis 3,160 ft.

Marion County: Skelly Oil 1 E. Wilson, SE SE NW 36-1n-4e, dry at 2,956 ft., Menard 2,032 ft., Cypress 2,457 ft., Benoist 2,651 ft., Aux Vases 2,727 ft., McClosky 2,846 ft., St. Louis 2,946 ft.

Schuyler County: Northern Ordnance 1 Yoat, W½ SE SW NW 1-3n-2w, of 4th pm., dry at 783 ft. Devonian lime at 664 ft.

Wayne County: Amsco 1 S. A. Clay, NW NW SE 16-1n-7e, dry at 3,251 ft. Upper Glen Dean 2,534 ft., Cypress 2,760 ft., Aux Vases 3,042 ft., McClosky 3,239 ft.

KANSAS

Kiowa County Gets Gas For First Production

KIOWA County entered the list of productive Kansas counties with completion of Lion Oil & Refining Co. 1 Alford, SE SE SW 14-30-19w, as a 3,500,000 cu. ft. gas well from Mississippi lime at 5,035-53 ft. The well was drilled to a total depth of 5,850 ft., after topping the Arbuckle at 5,787 ft. After setting 5-in. casing at 5,113 ft., casing was perforated and the Mississippi acidized with a total of 10,000 gal. Rock pressure is reported 1,100 lb.

Barber County.—Gulf Oil Corp. 1 Good, SE SE SE 28-30-12w, northeast of the Lake City pool, continued testing and made 50 bbl. of oil and 18 bbl. of water in 7 hours from Arbuckle pay at 4,638-45 ft.

Ellis County.—Sunray Oil Co. 1 Orth, NE NE SW 2-14s-20w, northwest of the Kraus pool, topped the Arbuckle at 3,833 ft., acidized and is showing for a good producer.

New operations reported for the week totaled 33, of which 12 were wildcat starts. The new wildcats were well scattered with two for Cowley County, two for Ellis County, two for Graham County, one for Norton County, two for Russell County, and one each for Sedgwick, Stafford and Sumner counties.

KANSAS WILDCAT COMPLETIONS

Barton County: Coralena 1 Bitters, SE SE NW 31-16s-15w, dry, TD 3,491 ft., Dodge 3,226 ft., Kansas City, 3,270 ft. Coralena 1 Funk, NE NE NW 18-16s-15w, dry, TD 3,446 ft., Dodge 3,176 ft., Kansas City 3,221 ft.

Butler County: Texas 1 Bales, NE NE NE 30-27s-3e, dry, TD 3,280 ft., Simpson 3,148 ft., Arbuckle 3,228 ft.

Ellis County: J. H. Jones and K. F. Wilson 1 Edwards, N/2 NE SW 33-15s-20w, dry, base Kansas City 3,852 ft., conglomerate 3,931 ft., TD 3,970 ft.

Norton County: Tom Allen & Aylward 1 Comstock, SW SW SW 3-4s-23w, dry, TD 3,900 ft., Arbuckle 3,842 ft., weathered quartzite 3,871 ft.

Pratt County: Skelly 1 Schaw, NW NW NW 4-29s-13w, discovery, pumped 142 bbl. of 38.5° gravity oil from pay zone at 4,489-99 ft., TD 4,606 ft., Simpson shale 4,487 ft., Simpson sand 4,490 ft., crystalline Viola 4,421 ft., cherty Viola 4,426 ft., Arbuckle 4,581 ft.

Rush County: Wolf Creek 1 Thalheim, S/2 SE NE 1-19s-20w, dry, TD 4,145 ft., Simpson 4,088 ft., Arbuckle 4,100 ft.

Stafford County: Amerada 1 Alpers, NW NW NE 25-21s-13w, dry, TD 3,702 ft., Simpson 3,636 ft., Arbuckle 3,659 ft.

MISSOURI WILDCAT COMPLETION

Holt County: Miller & Harner 1 Moss, NW NW NW 5-59n-37w, dry, TD 2,179 ft., Mississippi lime 1,722 ft., Hunton 2,141 ft.

WILDCAT COMPLETIONS AND DISCOVERIES

	Week ended September 16, 1944					Cumulative Total, 1944				
	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
Ohio	0	0	1	2	3	1	0	13	51	65
Indiana	1	0	0	0	1	4	0	0	18	22
Illinois	1	0	0	10	11	24	0	0	226	250
Kentucky	0	0	0	3	3	13	0	0	64	77
Michigan	1	0	0	5	6	11	0	2	175	188
Kansas	1	0	0	7	8	38	0	6	307	351
Nebraska-Missouri-Iowa	0	0	0	1	1	1	0	0	10	11
Oklahoma	2	0	0	11	13	47	0	19	195	261
Texas:										
North Central	1	0	0	6	7	49	0	1	221	271
West	3	0	0	5	8	32	0	3	123	158
Panhandle	0	0	1	0	1	0	0	2	8	10
Eastern	0	0	0	2	2	5	0	1	90	96
Gulf Coast	0	0	0	5	5	27	9	13	171	220
Southwest	0	0	0	6	6	18	4	14	169	205
Total Texas	4	0	1	24	29	131	13	34	782	960
Louisiana:										
Northern	1	0	0	1	2	4	0	1	41	46
Southern	0	0	0	0	0	6	6	0	37	49
Total Louisiana	1	0	0	1	2	10	6	1	78	95
Arkansas	0	0	0	0	0	2	1	0	43	46
Mississippi	0	0	0	2	2	3	0	0	51	54
Alabama-Georgia-Florida	0	0	0	1	1	2	0	0	18	20
Montana	0	0	1	1	2	3	0	3	29	35
Wyoming	1	0	0	2	3	13	0	1	16	30
Colorado-Utah	0	0	0	1	1	2	0	1	24	27
New Mexico	1	0	0	1	2	5	0	3	42	50
California	0	0	0	1	1	4	0	7	140	151
Total United States	13	0	3	73	89	314	20	90	2,269	2,693
Total previous week	13	0	1	57	71					

Summary of August Completions*

	Comp.	Oil	Prod.	Gas	Dry	Under 1,000 ft.	1,000-2,500 ft.	2,500-5,000 ft.	5,000-10,000 ft.	Over 10,000 ft.	Total footage	Rigs and drilling
N. Y., Penna., W. Va.	613	256	315	78	†279	78	458	74	3	0	883,034	506
Ohio	84	17	212	37	30	10	28	45	1	0	222,318	197
Indiana	21	8	1,765	1	12	1	12	8	0	0	43,681	53
Kentucky	93	42	4,004	28	23	16	67	10	0	0	277,128	160
Michigan	65	23	7,175	10	33	4	38	22	1	0	144,767	170
Illinois	187	109	13,342	0	78	7	58	122	0	0	483,379	228
Kansas	172	87	43,188	3	83	0	20	148	4	0	594,505	275
Missouri-Iowa-Nebraska	1	0	0	0	1	0	1	0	0	0	1,453	11
Oklahoma	156	84	23,106	16	56	7	41	66	42	0	582,602	546
Texas:												
North Texas	112	55	25,047	0	57	12	36	40	24	0	377,954	106
West Central Texas	23	7	541	0	16	4	7	12	0	0	58,569	55
West Texas	132	107	56,538	1	24	2	14	66	49	1	598,838	406
Texas Panhandle	26	21	2,910	4	3	0	1	26	1	0	90,942	157
Eastern Texas	15	8	2,142	0	7	0	0	2	12	1	100,193	80
Upper Gulf Coast	69	40	8,570	3	26	0	3	9	51	6	467,200	110
Lower Gulf Coast	72	45	8,012	3	24	0	0	12	59	1	472,545	88
South Texas (San. Ant.)	16	5	399	0	11	3	2	8	3	0	50,415	11
South Texas (Laredo)	57	19	2,122	4	34	0	11	29	17	0	234,843	60
Total Texas	534	307	106,281	15	202	21	74	204	216	9	2,451,499	1,067
Louisiana:												
North Louisiana	33	10	723	10	13	3	13	12	5	0	102,257	66
South Louisiana	51	37	9,003	1	13	0	0	3	25	23	463,121	108
Total Louisiana	84	47	9,726	11	26	3	13	15	30	23	565,378	174
Arkansas	18	8	1,415	0	10	1	2	8	7	0	83,465	41
Mississippi	16	8	2,819	0	8	0	0	2	12	2	58,900	58
Alabama-Georgia-Florida	7	2	100	0	5	0	0	3	4	0	39,391	17
Montana	56	32	5,819	14	10	6	29	18	3	0	128,042	130
Wyoming	18	15	5,023	0	3	1	1	13	3	0	73,540	104
Colorado	4	2	1,060	0	2	0	0	1	3	0	23,905	34
New Mexico	24	12	2,714	1	11	2	2	12	7	1	88,164	100
California	162	141	28,643	3	18	6	61	65	29	1	548,597	258
Total August	2,305	1,200	256,707	191	†914	163	905	836	365	36	7,333,328	4,132
Total July	2,162	1,099	258,868	259	‡804	111	830	841	339	41	6,457,516	4,100

*Four weeks ending August 26. †Includes 250 service wells. ‡Includes 201 service wells.

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Dependability is the outstanding characteristic of "Caterpillar" dealers, too. Today they are in a position to give your "Caterpillar" Diesel equipment the kind of inspection, adjustment, maintenance and repair it needs to work at peak efficiency from now until Victory is won. Call on *your* "Caterpillar" dealer regularly.

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***DEPENDABLE* is the word for "Caterpillar" Diesel**

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TO WIN THE WAR: WORK—FIGHT—BUY MORE WAR BONDS!

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Elevators

Type C

Automatic opening and closing speeds up round-trip time. Self-locking latch freezes latch in closed position when under stress. Light weight with great strength. Regular and upset types for either drill pipe or tubing.

SEE COMPOSITE CATALOG—PAGES 3101 to 3120

WEB WILSON
Oil Tools
W. W. WILSON BUILDING
HUNTINGTON PARK, CALIF.

PROVED
IN PEACE—IN WAR

'BESTOLIFE Lead Seal Joint Compound has been used successfully in the Oil and Refining industries for the past fifteen years. During that time, it has proved itself superior in protecting threads and in providing tight joints which can be broken easily.

Today, 'BESTOLIFE has enlisted in the Navy, Merchant Marine and Defense Plants for the duration, and we are proud of this assignment to help in the Victory effort.

But there are still ample stocks of 'BESTOLIFE available on any priority rating, at supply house field stores in every drilling district in the United States and Canada. USE 'BESTOLIFE Tool Joint Compounds for best results!

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Among the

Drilling Contractors

Johnson & Flesher Drilling Co. has been awarded the drilling contract on the Fox & Fox 1 Cherry, which was rigging up in C SE SE 5-1s-2e, near Davis in northern Murray County, Oklahoma. Contract is to the Bromide zone.

Newell & Chandler, of Calgary, Alta., drilling for Major Oils in the Barnwell area west of the original Taber field, have opened what may be an important new area with completion of Major-Taber 3, LSD 14, 9-9-17w4. Starting as a flowing well at 3,245 ft. with flush of 300 bbl., the producer later dropped to around 100 bbl., but is being put on the pump.

F. C. Hall has been awarded the drilling contract on the Anderson-Prichard Oil Corp. and Cimarron Gasoline Corp. 1 Lafon, in SW SW NW 5-19n-1w, Payne County, Oklahoma. This will be a test to 5,300 ft. or Wilcox sand on a 2,080-acre block, northwest of the Orlando area.

Fisher Drilling Co., Shreveport, La., closed a deal last week for a block in Holmes County, Mississippi, and was expected to be drilling on its location in SW SW 24-14n-2w, in the western part of the country.

Loffland Brothers Co. are drilling contractors on the California Co. 1 J. S. Nordan, in C NW SE 10-6n-8e, Jefferson Davis County, Mississippi. The well has started drilling.

Bering Co. is the drilling contractor on the P. G. Lake 1 B. S. Lyon, in the Heidelberg field of Mississippi. The location is 600 ft. north and 120 ft. southwest on the corner of SW¼ NE¼ 32-1n-13e.

Penrod Drilling Co. will drill the Hassie Hunt Tr. 1 Gertrude Taylor, in 31-1n-13e, the Heidelberg field, Mississippi.

Danciger Refineries has the drilling contract on the Sohio 1 Mackey, wildcat in 4-10n-3e, Claiborne County, Mississippi.

Camay Drilling Co., Los Angeles, has been awarded contract to drill a wildcat for Southern California Petroleum Corp. in the Stratford district of Kings County.

Mealy-Wolfe Drilling Co. and **Herndon Drilling Co.,** Tulsa, have staked location for 1 Honeycutt, a wildcat test in SE SE NW 9-13n-3e, southwest of Chandler, Lincoln County, Oklahoma. The project is on a farmout from Magnolia Petroleum Co.

Mohawk Drilling Co., Mount Vernon, Ill., has started pits and cellar for 1 Patton, in the center of NE NE 28-14n-4w, in the West Edmond field, which it is to drill for A. E. Anderson.

Duncan Drilling Co., Big Spring, Tex., has the contract for Ray Albaugh's 1 fee, to be drilled as a 5,000-ft. wildcat 12 miles north of Big Spring, in Howard County, on a block of 10,000 acres. The location is 660 ft. from the east line and 1,980 ft. from the north line of Section 29, Block 32, Township 2n, T.&P. Survey.

Richmond Drilling Co., Midland, Tex., was at 4,569 ft. in lime at 1 Nelson, which it is drilling for its own account in Section 34, Block M, EL Survey, northwest Dawson County, Texas. The lime was topped at 4,555 ft. on an elevation of 3,103 ft.

Manning & Brown, Inc., Denver, received contract from Mountain Fuel Supply Co. to drill a 10,000-ft. wildcat test on the Churches Buttes structure in Wyoming, 60 miles west of the Baxter Basin gas fields.

Schoenfeld-Hunter-Kitch Drilling Co., Oklahoma City, is the contractor in a proposed Devonian test in the Johnsonville pool of Clay County, Illinois, where The Texas Co. will deepen 1 Mary Greathouse, in SE NW 27-1n-6e.

Charles Baird, California drilling contractor, is drilling a new well on the Butler property at McVan for Butler Brothers Oil Co.

E. B. Hall & Co., drilling contractor, is starting work on a test in the Tejon Ranch district of California for O'Keefe & Merritt Co.

MISSISSIPPI

Natchez Pool Pay Zones Create Problems

JACKSON.—Further coring in Pure Oil Co. 2 McDowell, 12-6n-3w, second test in the Natchez pool of Adams County, has revealed a complicated pay zone situation. The first drill-stem test, which showed for 40 bbl. of condensate and about 3,000,000 cu. ft. of gas, was from 3 ft. of pay. Additional coring has found 12 ft. of salt-water sand immediately below this, followed in order by 10 ft. of tight sandy shale, 12 ft. of saturated oil sand and a final 8 ft. of salt-water sand. Liner will be set and a test made of the 12-ft. section of saturated oil sand.

Three wells were completing in the Heidelberg pool, estimated at 1,000 bbl., 300 bbl. and 175 bbl. and two Eucutta pool wells were finishing up, one looking good for 75 bbl. with a 2 per cent cut of b.s. and w., and the other a 150-bbl. well, cutting 4 per cent.

In Collier County, Florida, Humble Oil & Refining Co. 2 Gulf Coast Realty Co., SW SE 30-48s-30e, is coring at 13,220 ft. in lime with no encouraging shows as yet. Humble has completed a road to 3 Gulf Coast Realty Co., a location in SW SE 28-48s-30e, and is building roads to 4 Gulf Coast Realty Co., a location in SW NE 20-48s-30e.

In Choctaw County, Alabama, H. L. Hunt has completed 1 Scruggs, SE NE 32-11n-4w, in the Eutaw pay zone at 3,481-3,510 ft., the first well in the Gilbertown field to find production in this formation.

MISSISSIPPI WILDCAT COMPLETIONS

Issaquena County: Sun 1 Haynes & Johnson, SE SE SE 1-9n-8w, dry, TD 4,620 ft., Lower Cretaceous 4,560 ft.

Yazoo County: Sinclair-Kingwood 1 Deason, SW SE 25-12n-2e, dry, TD 5,610 ft., Wilburn 4,913 ft., Tuscaloosa 5,408 ft.

NORTH LOUISIANA WILDCAT COMPLETIONS

Bienville Parish: Southern Natural Gas 1 Cummings, 200 ft. NW of center, 1-16n-6w, 63 bbl. oil from pay zone 6,745-65 ft., TD 7,443 ft., Pettit 6,745 ft.

Morehouse Parish: Texas 2 Louisville Cooperage, 1,320 ft. S and 660 ft. W NEc of frac. sec. 36,23n-8e, dry, TD 4,917 ft.

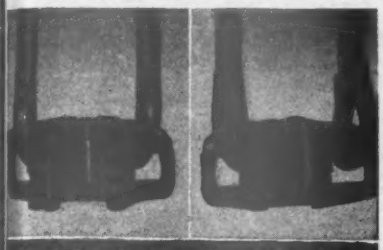
ALABAMA WILDCAT COMPLETIONS

Escambia County: Hunt 1 Foshee, SE SW 15-1n-10e, dry, TD 5,850 ft.

Compact Commission's Fall Meeting to Open October 5

OKLAHOMA CITY.—Interstate Oil Compact Commission will open its 3-day fall quarterly meeting in the Biltmore Hotel here October 5. Subjects before the commission will include the new West Edmond oil field, the British-American oil agreement, the responsibilities of states in postwar regulation of the oil industry, E. G. Dahlgren, acting secretary of the commission, said.

The first day will be devoted to meetings of committees and study groups. Gov. Andrew F. Schoeppel, of Kansas, chairman, will preside at the general open sessions beginning Friday morning, October 6, and continuing through Saturday. The governors of all oil-producing states and state and federal regulatory officials, as well as representatives of the industry throughout the country, have been invited to the meeting. Thirteen oil-producing states are members of the commission, representing approximately 80 per cent of the country's total oil production.



BJ "AA" ELEVATORS ARE REALLY BALANCED

By incorporating a newly devised roller type balancing cam in BJ "AA" Elevators the work of the derrick man is made much easier. Rated at 300 tons, with a safety factor of four to one, this elevator is made of high alloy steel—fully heat treated—flame hardened on the top bore to minimize upsetting—and is equipped with an unusually sturdy latch. Ask the BJ man or your supplier.

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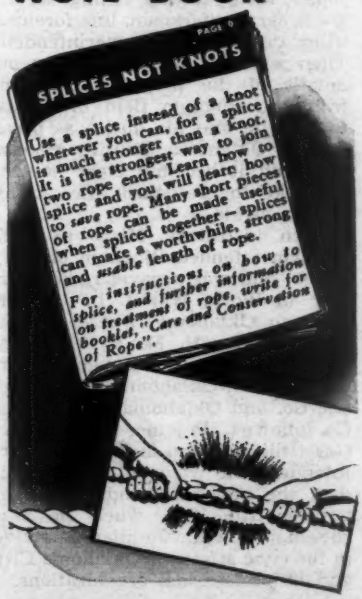
Rope CONSERVATION NOTE BOOK—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SPLICES NOT KNOTS
Use a splice instead of a knot wherever you can, for a splice is much stronger than a knot. It is the strongest way to join two rope ends. Learn how to splice and you will learn how to save rope. Many short pieces of rope can be made useful when spliced together—splices can make a worthwhile, strong and usable length of rope.
For instructions on how to splice, and further information on treatment of rope, write for booklet, "Care and Conservation of Rope".

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PERSONALS

Joullian Licked the Problems on His Way Up

ONE reason the multifarious problems incident to supervising Consolidated Gas Utilities Corp. in Oklahoma leave Edward C. Joullian unruffled is that he became familiar with most of them on his way up. Phases of the business which his 23 years' experience has covered include engineering, drafting, meter repair, meter testing, fitting, service work, service foreman, line foreman, utilization, and superintendent. Then add his part in working out details of the proposed pipe line from the Hugoton field in Kansas to Wichita and his duties as president of Oklahoma Utilities Association, and it becomes clear how he can take the responsibilities of his post in stride.

Born in Biloxi, Miss., in 1897, Joullian attended Bingham Military School and was a naval radio operator in World War I. In 1920 he went to Oklahoma, where he was employed by H. M. Byllesby Engineering & Management Corp. Service with Oklahoma Gas & Electric Co. and Oklahoma Natural Gas Co. followed. He joined Consolidated Gas Utilities Corp. in 1928 as superintendent. He was made vice president the next year and filled that position till 1939, when he was chosen president. Joullian is active in the civic affairs of Oklahoma City and in professional organizations.

Paul Paine, a director of Formax Oil Co., Los Angeles, has been elected vice president to succeed L. T. McCutcheon, who died recently. The latter was one of the four "Macs" for whom the company was named and had been in active charge of operations.

J. W. Binhammer, formerly in charge of the coordinating department of Standard Oil Co. (Indiana), has taken over the duties of auditor of the manufacturing department. **W. B. Haas,** who held that post, has been placed on leave owing to ill health and will retire January 1, 1945, after 40 years of service. **R. M. Eberly,** formerly an assistant of Haas, has succeeded to his post. **S. J. Sieben,** formerly in the cost department, has been advanced to assistant, manufacturing.

K. S. Adams, Bartlesville, Okla., president of Phillips Petroleum Co., who has been inspecting the company's operations in the Rocky Mountain area, was quoted by Denver newspapers as saying postwar reconversion for the petroleum industry will be "as quick and smooth as turning a well-oiled valve."

C. S. BEESEMYER

Clarence S. Beesemyer, vice president of Gilmore Oil Co., has been elected president, succeeding **Earl B. Gilmore,** who resigned because of ill health resulting indirectly from an injury suffered when thrown from a horse. Beesemyer has been connected with Gilmore since 1912, when he started as a roustabout. He is chairman of marketing for District 5, Petroleum Administration for War, and is a member of Petroleum Industry War Council.

Nicholas L. Gianakos, a chemist at the Torrance plant of Shell Chemical Co., has been advanced to research chemist. **Frank H. Lucas,** chemist at the Martinez refinery, has been promoted to research chemist at the plant.

Maj. William H. Besselman, who was superintendent of the Westwego, La., terminal of General American Tank Storage Terminals when he entered war service, has received the Legion of Merit Award for "exceptionally meritorious conduct" as a port commander in Iraq. The citation says he "displayed marked ability and resourcefulness" in meeting difficult problems.

David G. Hawthorn, formerly in the production division of Petroleum Administration for War, engaged in secondary-recovery investigations, has become associated with **E. O. Bennett,** consulting engineer, in Houston.

L. E. Border, who was head of pilot plant-catalytic cracking at the Wood River refinery of Shell Oil Co., Inc., has been made head of the cracking department.

Lt. (j.g.) W. D. Frazell, who before his enlistment in the Navy was a geologist for Union Producing Co., Shreveport, is now aboard a merchant ship as an armed guard.

E. O. Perkins has been appointed general superintendent of the terminal division, refining department, of The Texas Co., succeeding **J. E. Blake,** who has been made assistant general sales manager of foreign operations.

W. A. Bugge has been appointed district engineer for the Pacific Coast division of The Asphalt Institute, with offices in Portland and Seattle.

V. R. Oakley, formerly general superintendent of Bareco Oil Co., Tulsa, has been made vice president in charge of manufacturing.

Merle Blakely, for the past 5 years assistant director of public affairs for Public Service Co. of Oklahoma, has joined the public-relations staff of The Carter Oil Co.

A. H. Robinson, formerly in the land department of Barnsdall Oil Co. in Tulsa, has been placed in charge of a land office which the company has opened in Texarkana, Ark.

George W. Culpit, Jr., formerly a chemist for the du Pont interests, has been engaged as chief chemist for the motor-fuel division of the Oklahoma Corporation Commission, succeeding **Paul Williams,** who resigned. Cupit has done research work in petroleum refinery chemistry and utilization of byproducts.

Industrial Items

Rex Chabelco Chain Manufactured in Three Widths

The Rex No. 3100 series even-pitch roller chains are parallel manufacturer's standard roller chains and are offered for application where the offset sidebars are advantageous. They are especially used in oil fields and on construction machinery. The physical properties—ultimate strength, yield point, fatigue limit, hardness of round parts, are identical to straight sidebar chains of equal pitch. The control dimensions—pitch, roller diameter, face of roller—are also identical in both styles of chains. Sprockets are the same as those used for manufacturer's standard roller chain belts.

Offset sidebar chains wear equally in each link. Pitch elongation due to normal wear is evenly divided over all links. Better sprocket action is obtained, for with equal pitch elongation in each link, smoother sprocket action results.

The offset chains are easier to take apart and put together. Any number of links may be used in a drive, or an adjustment made without the necessity of special links.

Ware Named by S. M. Jones

S. M. Jones Co., manufacturers of sucker rods, announces the appointment of William M. Ware as district representative. Ware will spend a major part of his time in Tulsa and vicinity, according to L. J. Pundt, sales manager.

Before joining the S. M. Jones staff, Ware had been associated with Texas Pipe Line Co., and was previously connected with an industrial engineering firm with headquarters in Chicago.

General Controls Moves to New Quarters

The New York factory branch of General Controls, Glendale, Calif., manufacturers of automatic pressure, temperature and flow controls, has occupied new and larger quarters in the Architects Building, 101 Park Avenue, New York City. The Cleveland branch also moved into new quarters recently at 3224 Euclid Avenue, with branch manager L. E. (Rusty) Wetzell in charge.

John Hammond has had 9 years of experience in the controls business on the Atlantic seaboard. As salesman, sales engineer, and branch manager, he has installed control systems from Richmond to Boston. At war's start, he took an active part in General Controls Co.'s pioneer work in the application of automatic shutoff valves to aircraft uses.

"In our sales and service offices on the sixth floor," says Hammond, "we have complete facilities for doing a real sales engineering and counseling job for our users. There are practical working displays showing the many uses of our controls in various industries. Customers' needs can be filled quickly from a large, amply filled stockroom. On the ground floor we have a 7-ft. high display with 'General Controls' in lucite letters that can be seen from Park Avenue."

Norton Names Curtis Manager Of Sales Engineering

Fred L. Curtis has been appointed manager of the sales engineering department by Norton Co., Worcester, Mass. He will be located in Worcester and will report directly to R. M. Johnson, general sales manager. Curtis has been with Norton for 16 years, first as abrasive engineer in Jackson, Mich., and for the last 5 years was abrasive engineer in Detroit.

Fred W. Grant has been appointed merchandising engineer by Norton. He also will be located in Worcester reporting directly to R. M. Johnson. Grant has been with Norton for over 30 years and for the last 19 years has been abrasive engineer in the Milwaukee territory.

Paul H. Carlson has been appointed abrasive engineer for Milwaukee succeeding Grant and E. C. Willey has been appointed abrasive engineer for the Moline, Ill., area succeeding Carlson.

Two More Briggs Clarifiers

Briggs Clarifier Co. has added two more models to its line.

Briggs Series G clarifiers are relatively small-capacity units primarily designed for oil-filtration service on mobile, marine and light-to-medium-duty stationary engines with a minimum flow capacity of 3 g.p.m. They are supplied with adjustable mounting brackets for direct attachment—usually to the side wall of the engine.

Briggs Series F fuel-oil clarifiers are designed for diesel and gasoline engines consuming from 5 to 10 gal. per hour. The small compact design makes them especially adaptable to mobile diesels used in trucks, buses, tractors, drag lines, cranes and field pump units.

Marsh Elevated by Kennedy

Kennedy Valve Mfg. Co., Elmira, N. Y., announces the election of Leon H. Marsh as vice president and sales manager. Marsh has been associated with the company for more than 25 years. After having been assistant sales manager for many years, he was made acting sales manager in 1941, upon the death of Clarence H. Kennedy, and was promoted to the position of sales manager in 1942.

Berry Named Metallurgist For Beaird Company

Clayton D. Berry, formerly metallurgist for Sivyer Steel Castings Co., Milwaukee, has joined J. B. Beaird Co., Shreveport, as metallurgist in charge of heat-treatment development and procedures in the steel foundry division. Before his connection with the Sivyer company he was metallurgist in heat treating for J. I. Case Co., Racine, Wis.

Four New Insulating Materials

The insulation division of the Eagle-Picher Sales Co. has added four new products to its line of insulating materials.

The new products have been named: "Eagle Swetchek," "Eagle Drycote," "Eagle Hadesite," and "Eagle 43 Finishing Cement."

Eagle Swetchek is an insulation for minimizing condensation, for use on cold water lines, water coolers and softeners, storage tanks, filters and condensers. Eagle Drycote is a plastic coating, white in color, and packaged in dry form. When mixed with water and applied by trowel or hand application to any clean dry surface, it becomes smooth and glossy white in color and sets into an extremely hard surface. It is fireproof.

Eagle Hadesite is a fireproofing insulating cement for high-temperature work. Mixed with water it is troweled to a smooth hard finish of salmon color and is used primarily for fireproofing structural steel, lining high-temperature ducts, firedoors, etc. Hadesite is used to temperatures to 1,900° F.

Eagle "43" finishing cement is used for finishing interior insulation work where an extremely hard, smooth surface is desired. It can also be painted and withstands temperatures to 800° F.

Quaker Oats Organizes Chemical Department

Quaker Oats Co. announces the formation of a chemicals department. This department will integrate the functions of sales, research, and production heretofore carried out by several divisions of the company. The furfural and technical divisions become merged in the chemicals department under the new plan, and their former designations discontinued.

Lauren B. Hitchcock has been appointed manager of the chemicals department, located at the general offices, 1900 Board of Trade Building, Chicago. For the past 9 years he has been with Hooker Electrochemical Co., Niagara Falls, in both research and sales departments, lately as manager of sales development.

Berkley Promoted by Republic Flow Meters

Republic Flow Meters Co., Chicago, announces the appointment of Merrill Berkley as its exclusive representative in southern California and portions of Nevada and Arizona. Berkley has transferred from Republic's Chicago headquarters and will handle sales and application engineering and equipment service for Republic and allied manufacturers.

Berkley's office is in the Lincoln Building, 742 South Hill Street, Los Angeles.

Slavens Joins Baroid

Baroid Sales Division of National Lead Co. announces the appointment of O. C. Slavens as salesman for the Baroid V-belt shock absorber and other specialty products in California. Slavens comes to Baroid from Lacy Oil Tool Co. with which organization he has been associated since 1935. He has worked in the drilling and producing departments of the oil industry since 1921 in both the Mid-Continent and California.

Promotions Announced for Hendy Executives

Promotions for top-ranking executives of the Joshua Hendy Iron Works have been announced by Charles E. Moore, president of the manufacturing company, as he revealed that Capt. E. D. Almy, assistant general manager, will serve as manager for the Crocker-Wheeler division of the organization at Ampere, N. J.

A. J. M. Baker, Crocker-Wheeler manager, has resigned to become executive vice president and general manager of E. W. Bliss Co., with headquarters in New York.

Succeeding to Almy's post as assistant general manager in Sunnyvale is Harry C. Gunetti, who has served for more than 3 years as general superintendent. Robert Mann, former assistant general superintendent, becomes general superintendent, and Clifford Sayre, former night general superintendent, becomes assistant general superintendent.

MARKET QUOTATIONS

Prices as of September 19, 1944

(This service is abbreviated because most refinery products are selling at the Government's price ceilings. Quotations on other products than those shown here furnished on request. Quotations are f.o.b plant in tank cars and in cents per gallon.)

REFINERY GASOLINE

Octane (A.S.T.M.):	**75†**	**70-74**
Mid-Continent*	**6.75**	**5.87½**
Gulf Coast	**6.75**	**5.62½**
Northeast Coast		**6.07½**
California		**6.50-7.00**

***Basic Oklahoma Group 3. †1939 C F R (research method).**

NATURAL GASOLINE

Grades:	**28-70**	**to 3**
Oklahoma (Group 3)	**4.750**	**5.70**
North Texas	**4.375**	**5.25**
North Louisiana	**4.375**	**5.25**
California	**4.875**	**5.50**

CRUDE-OIL PRICES

Representative posted schedules per bbl	
East Texas	**$1.25**
Conroe	**1.43**
Tepetate, Louisiana	**1.18**
Illinois basin	**1.37**
Pecos County, Texas	**.93**
Bradford, Pennsylvania	**1.00**
Van, Van Zandt County, Texas	**1.00**

Note: Exclusive of subsidy.

GRAVITY SCHEDULES

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Texas	West Texas*
18-18.9	$0.80	....	....	....
19-19.9	.84	....	$1.06	$0.70
20-20.9	.88	$0.85	1.08	.72
21-21.9	.92	.87	1.10	.74
22-22.9	.96	.89	1.12	.76
23-23.9	1.00	.91	1.14	.78
24-24.9	1.03	.93	1.16	.80
25-25.9	1.07	.95	1.18	.82
26-26.9	1.11	.97	1.20	.84
27-27.9	1.15	.99	1.22	.86
28-28.9	1.18	1.01	1.24	.88
29-29.9	1.20	1.03	1.26	.90
30-30.9	1.23	1.05	1.28	.92
31-31.9	....	1.07	1.30	.94
32-32.9	....	1.09	1.32	.96
33-33.9	....	1.11	1.34	.98
34-34.9	....	1.13	1.36	1.00
35-35.9	....	1.15	1.38	1.02
36-36.9	....	1.17	1.40	1.04
37-37.9	....	1.19	1.42	1.06
38-38.9	....	1.21	1.44	1.08
39-39.9	....	1.23	1.46	1.10
40 and above	....	1.25	1.48	1.12

***Includes Lea County, New Mexico.**

A.P.I. REFINERY REPORT

Week ended September 9, 1944
(Figures in thousands of barrels)

	Dly. crude runs to stills	Stocks— Gasoline	Residual	Gas oil
Appalachian	158	3,841	500	773
Ind., Ill., Ky.	738	17,141	4,021	6,249
Okla., Kan., Mo.	371	6,697	1,501	1,971
Censored area*	2,457	36,472	19,852	23,124
Rockies	118	1,373	678	890
California	744	13,752	34,185	10,546
Total 9- 9-44	4,584	79,576	60,735	43,053
Total 9- 2-44	4,592	79,921	59,876	41,564
Total 9-11-43	4,225	71,018	66,743	38,051

***Reports combined on East Coast, Texas Gulf Coast, Louisiana-Arkansas and Inland Texas at request of PAW.**

CRUDE-OIL STOCKS
(Bureau of Mines Estimate)

Week ended:	**Bbl. of crude***
September 9, 1944	**220,623,000**
September 2, 1944	**223,482,000**
September 11, 1943	**234,389,000**

***Excludes unrefinable California stocks.**

CALENDAR

October

American Association of Oilwell Drilling Contractors, Blackstone Hotel, Fort Worth, October 3-4.

American Gas Association, annual meeting, Engineering Societies Building, New York, October 5.

INTERSTATE OIL COMPACT COMMISSION, fall quarterly meeting, Biltmore Hotel, Oklahoma City, October 5-7.

I.P.A.A. board of directors, Dallas, Tex. October 9-11. (Takes place of anniversary meeting previously scheduled.)

C.N.G.A., annual meeting, Biltmore Hotel, Los Angeles, October 12.

A.I.M.E., Pacific Section, annual fall meeting, Ambassador Hotel, Los Angeles, October 20.

PIWC, regular monthly meeting, New Interior Building, Washington, D. C., October 25.

Public Land Lease Extension Approved

WASHINGTON. — The public lands committees of both House and Senate last week recommended passage of bills extending the term of oil and gas leases expiring on or prior to December 31, 1945. Passage of the bills (S. 2111 and H.R. 5283) the committee reports pointed out, would protect small oil operators and encourage needed wartime drilling. Approximately 200 leases would be affected.

Under present procedure, leases are issued by the secretary of interior for 5 years and so long thereafter as oil or gas is produced from leased land. A lessee failing to find oil within the term has a preference right to a new lease, provided the land is not then within a producing structure. In this case, the lessee must bid against competitors.

Many lease holders, the committee of the House reported, have discovered oil shortly before the 5-year period expired and assigned portions of their leases in undrilled sections to others. Under a General Land Office ruling, in such cases, each assigned portion of the original lease is separate, and production from each is necessary to extend the term for that portion.

Phillips Posts Prices in Two Texas Oil Fields

BARTLESVILLE, Okla.—Phillips Petroleum Co., which recently opened the South Tyler field, in Smith County, with its 1 McMinn, has posted a price of $1.25 a barrel for its crude purchases in that field. This is an initial posting, subject to approval of Office of Price Administration. Phillips also has posted $1.25 a barrel for the East Texas field, the company's first posting in that field. Both of these prices are effective as of August 1.

Classified Advertising

UNDISPLAYED RATE

8 CENTS A WORD, minimum charge $2 per insertion.

SITUATIONS WANTED, 4 cents a word, minimum charge $1.

BOX NUMBERS, count 9 words when replies are to be sent to our Tulsa Office.

10% DISCOUNT if 3 insertions are ordered at one time, with check accompanying order.

All classified advertising payable in advance.

DISPLAYED—PER INCH

Classified display advertising set in single or double column style:

1 inch	**1 time**	**$7.00**
1 inch	**13 times**	**6.50**
1 inch	**26 times**	**6.00**
1 inch	**39 times**	**5.50**
1 inch	**52 times**	**5.00**

Rates are governed by total space used within 12 months from date of first insertion. Credits are allowed when lower rates are earned.

FORMS CLOSE 5:00 A.M. MONDAY
Advertising will be accepted in order received, to extent of available space.
Published Each Saturday

FOR SALE—PUBLICATIONS

FOR SALE

Out of print publications of the U. S. GEOLOGICAL SURVEY and U. S. BUREAU OF MINES
Write for lists specifying states in which you are interested.

JAMES C. HOWGATE, Bookseller
120 So. Church St., Schenectady 5, N. Y.

PATENT ATTORNEYS

PATENTS, Trade-Marks, Booklet, "General Information Concerning Inventions and Patents" and "Free Schedule" sent without obligation. Established 1915. Lancaster, Allwine & Rommel, Suite 418, Bowen Bldg Washington 5, D. C.

FINANCING

CAPITAL SEEKERS—Interested in raising $25,000 or more for a legitimate project should write to AMSTER LEONARD, Fox Theater Bldg., Detroit 1, Mich.

WANTED

FACILITIES available for gathering and storage of crude including tow boat and two 2,500 bbl. shallow draft barges working radius of 75 miles New Orleans with 55,000 bbl. deep water storage New Orleans. We desire to exchange our transportation and storage facilities, even at a sacrifice, to obtain approximately 15,000 to 25,000 bbl per month 37 gravity sweet crude. Missouri Petroleum Sales, 8530 West National Ave. Milwaukee 14, Wis.

SALES AGENCY FOR OUTSTANDING VALVE LUBRICANTS OFFERED

We want to place the exclusive sales agency for the unique valve lubricants we manufacture as a specialty—acid resistant SEALACID, hydrocarbon resistant STYROSEAL, heat resistant LAVA-SEAL, alkali resistant SEALALKALI—with first-class firms, or individuals, in their respective sales districts in the U.S.A. and Canada.

The compounds listed above are in regular use in a large number of the leading oil refineries, synthetic rubber plants, chemical factories, etc. They are clean and easy to handle, packed in paste and stick form.

Only such firms or persons of excellent reputation, who are well organized to handle this article, will please write and outline their proposed sales district to

CHEMOTEK MANUFACTURING CO.
Commerce Building,
Houston, Texas